PETROLEUM PROCESSING

including Petrochemical Processing Section

JANUARY 1953

New Capacity in '53

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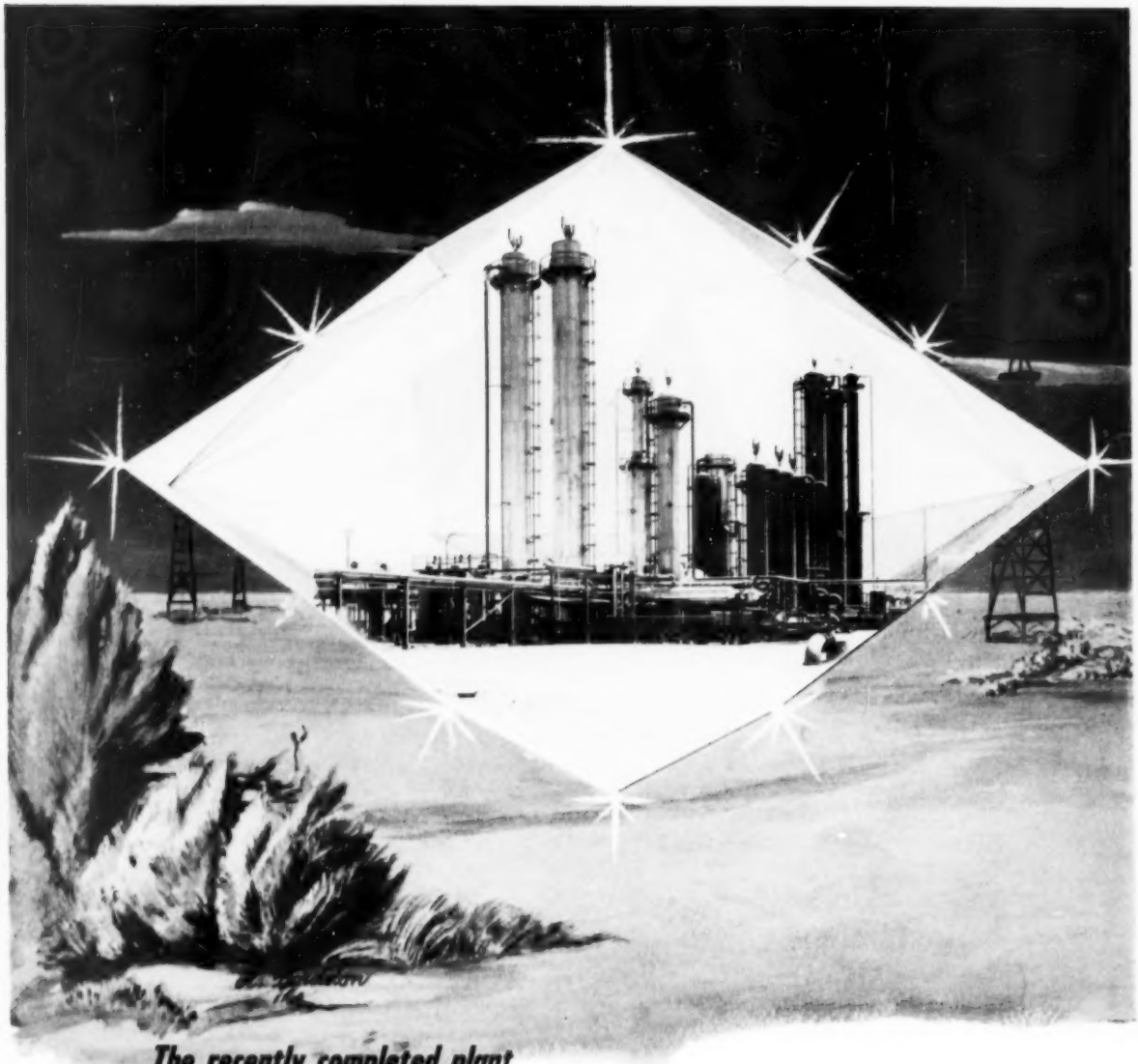

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PETROLEUM PROCESSING

Covering petroleum research and the design, management, operation and maintenance of plants processing hydrocarbon materials into fuels, lubricants and chemicals

January, 1953
Vol. 8, No. 1

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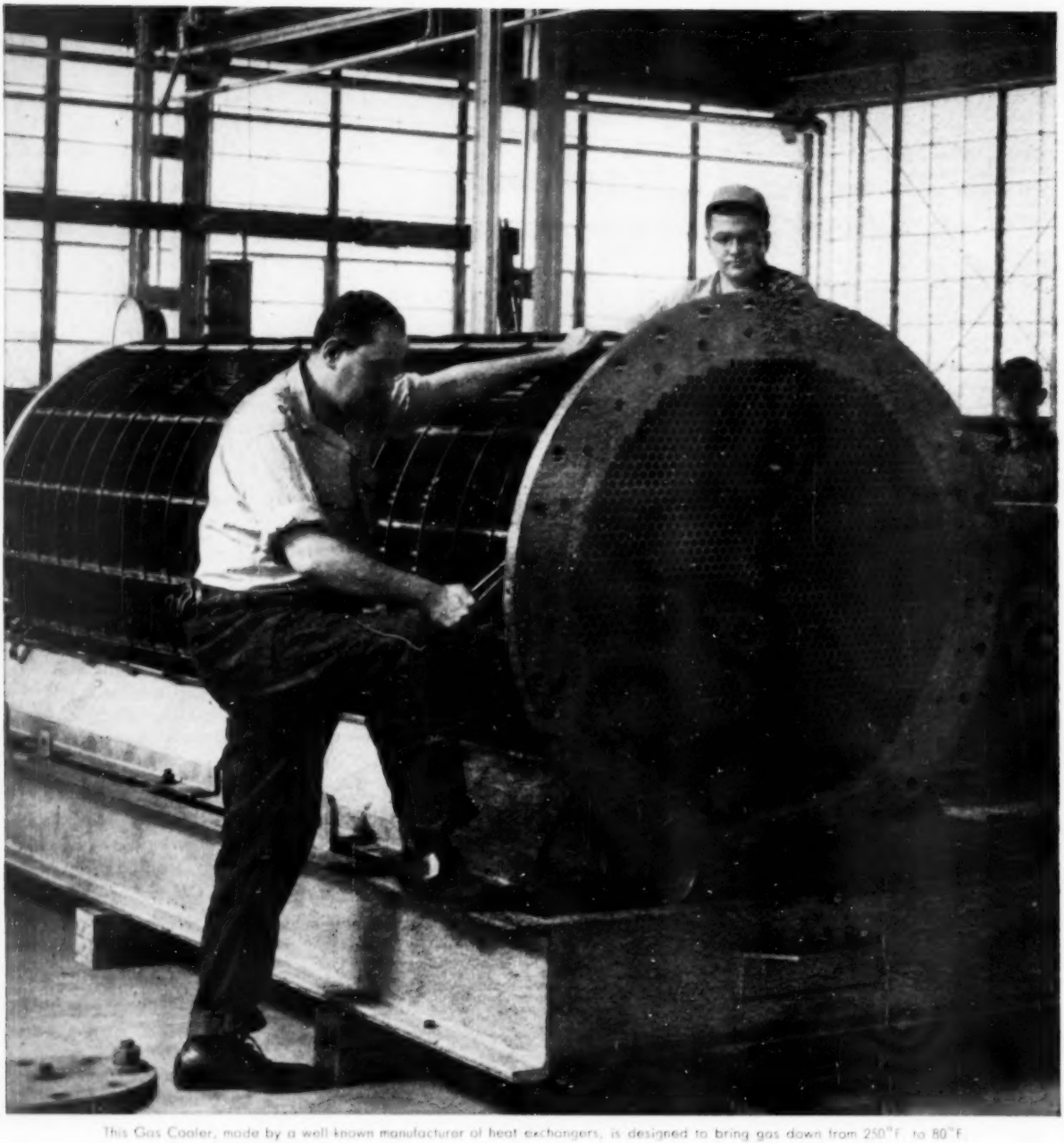

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PETROLEUM PROCESSING

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What Makes You Read Certain Articles?

It's a shame we can't 'phone each of you every month and say "Look, Tom, there's an article on pg. 55 that's right up your alley," or "say, Ed, don't miss the story on pg. 81; it's got some answers for you on your separation problems."

We don't expect you to read every article. But we do want to make sure, for example, that every cracking unit man reads the articles we print pertaining to his problems.

The next best thing to 15,000 'phone calls every month is to do everything we can to "sell" you on articles in your field when you open up your latest copy of PETROLEUM PROCESSING. One of our most important jobs as editors is to interpret a story and present it in such a manner that you get the main idea of what it's all about at a glance. You are all busy people, and it goes without saying that we're only one of many interests competing for your time—at your home and in your plant.

How do we convince you, then, that a certain article will be of help to you? How do we take the "raw crude" information, "refine" it into a finished story, inject illustrations as "additives," "treat" it with an eye-attractive layout, and perhaps add a dash of "color" to make the product you want to "buy" with your time?

The answer is rather complex. Let's take just one phase of it for now. To begin, when you look through a magazine your eye is in constant motion—glancing from one page to the next, from one point on a page to another.

Our main job, then, is to catch your eye and force it down into the page, into starting to read an article. Sounds insidious, doesn't it? Subtle, perhaps, but not insidious. We assume that some of you really want to read any given article, but we have to help convince you and make it easier for you to get started. If we didn't, it would be a little like giving you a power saw with no switch on it, or a hammer with a short handle.

For help we go back many years to Confucius. We print a picture or a chart right at the start of the article. We select one, if possible, that points up the main theme of the story.

Then we write a headline or "title" that ties in with the story and with what the illustration tells. Of course, you're right when you say "But you don't do that all the time." Sometimes we have no pictures; some articles can't be represented by any illustration; and now and then we simply miss the boat.

There's a lot more to tell you on what makes you want to read an article—but we've run out of time this month.

During the next hour and more that you'll probably spend with this issue, see if you don't find yourself glancing first at the lead illustration and then the headline. If we've done our job right and the subject interests you, you'll probably start reading—rather than moving on to the next page.

Virgil Guthrie

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The weekly oil marketing magazine, covering news, prices, transportation, storage, merchandising

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Tri-Sure Products Limited, St. Catharines, Ontario, Can.

(To obtain more data on advertised products see page 128)

What's Happening . . .

Expansion

. . . **Pacific Oil & Refining Co.** plans to erect a 10,000 b/d refinery at Tacoma, Wash., to include catalytic cracking, polymerization and related facilities. Plant would use Canadian crude from Trans-Mountain Pipe Line terminus at Vancouver, and would be located near water front to aid movement of crude and products. Application has been made for accelerated amortization and materials aid, with plant cost indicated at $5,667,500. Plant is scheduled for completion in early '54, but construction contracts have not yet been awarded. Geo. Armistead & Co., Washington, is engineering consultant.

Pacific is newly-formed company with J. E. Erickson, who also heads Northwest Refining Co., St. Paul, as vice-president. An unidentified "group of Chicago and Minneapolis businessmen" are said to have made an initial investment in the company in excess of $6 million.

. . . **Phillips Petroleum Co.** plans to boost capacity of its refinery at Woods Cross, Utah by 50% within the next two years. Plant was recently enlarged from 4200 b/d to 12,000 b/d, and announcement of further increase to 18,000 b/d was made by Phillips' Board chairman K. S. Adams while attending dedication of new catalytic cracking unit at Woods Cross.

. . . **Anderson-Prichard Oil Corp.** has acquired the 13,000 b/d refinery at Arkansas City, Kan. and other assets of Kanotex Refining Co., and plans to immediately increase this plant's capacity to 15,000 b/d and ultimately to 20,000 b/d. Anderson-Prichard already has plants at Cyril, Okla. and Colorado City, Texas.

. . . **United Refining Co.** is building a 2500 b/d Catformer (licensed by Atlantic Refining Co.) at its 5500 b/d Warren, Pa. refinery. Blaw-Knox Construction Co. is acting as designer and contractor. Plant completion is scheduled for August '53.

. . . **Kamloops Refinery Syndicate** has reported plans for building a 2,500 b/d refinery near Kamloops, with completion scheduled for spring of 1954, processing Alberta crude piped through the Edmonton-Vancouver line.

. . . **Socony-Vacuum Oil Co.** will build a new 15,000 b/d TCC airlift unit at its East St. Louis, Ill. refinery, to replace an existing Houdry catalytic cracking unit. Construction contracts have not yet been let.

. . . **Colt-Worthington Oil Works, Inc.** has broken ground for new blending and compounding plant at Westbury, L. I. Intended for completion next spring, new plant will have more than double capacity of company's present facilities at Garden City, L. I.

. . . **Delta Refining Co.** is raising capacity of its Memphis, Tenn. refinery from 4000 b/d to 6000 b/d with installation of Thermofor catalytic cracking unit and complete revamp of existing facilities. Storage capacity will be doubled and new laboratory and truck loading facilities will be built. Work should be finished in April or May, '53. Delta is owned by MFA Oil Co., subsidiary of Missouri Farmers Assn., Columbia, Mo., co-op.

. . . **Richfield Oil Corp.** has let a $1 million contract to Fluor Corp. for design, engineering and construction of a catalytic polymerization unit at its Watson, Calif. refinery. Unit is due for completion early in '54, and is part of Richfield's $40 million expansion program (What's Happening, Aug. '52, p. 1055).

. . . **Refinery Operators Ltd.** has started construction of a new 5000 b/d topping plant at Coleville, Sask., southwest of Saskatoon. Plant is expected to be in operation in April.

. . . **Shell Oil Co.** will increase capacity of its natural gasoline plant at Ventura, Calif. by one-third, from present 4,524 b/d capacity. Contract for extensions and revisions of plant was awarded Fluor Corp. Construction is scheduled to start March 15 with Sept. 1, 1953 as target date for completion.

. . . **Union Oil Co. of Calif.** has dropped option on a million-acre prospective refinery site in Puget Sound area (What's Happening, Dec. '52, p. 1703). Spokesman said Union has no other refinery site and reiterated that company has no plans for a Pacific Northwest refinery.

. . . **Suntide Refining Co.'s** 28,000 b/d refinery construction program at Corpus Christi, Texas, is proceeding on or ahead of schedule, with foundations completed for the crude topping vacuum distillation and 15,000 b/d catalytic cracking units, as well as several miscellaneous towers. It now is anticipated operations will commence in early fall, 1953 (See What's Happening, Oct. '51, p. 1051; March '52, p. 271, and July '52 p. 903).

Petrochemicals

. . . **Allied Chemical & Dye Corp.** has another petrochemical iron in the fire—its Semet-Solvay Division is now producing a new polyethylene material called "Alcowax" at Buffalo, N. Y. The product has wax-like hardness, melts at about 100° C., is white translucent in color, and is tasteless, non-toxic and substantially odorless. A small plant unit is now in production, with a full-scale plant now under construction and scheduled for completion this year.

. . . **Monsanto Chemical Co.** has started production of acetylene from natural gas at its Texas City, Texas plant. From the acetylene Monsanto is producing principally acrylonitrile (first shipment was made Dec. 30), and also ethylene dichloride and vinyl chloride monomer.

. . . **Heyden Chemical Corp.** and **Monsanto Chemical Co.** jointly will build a plant to make methanol at

Information on these pages is obtained through the nation-wide news coverage service of PLATT'S OILGRAM NEWS

Texas City, Texas. The plant will adjoin Monsanto's new acetylene plant there, operating on by-product gas from it, and will have a capacity of 25,000,000 gal. a year.

. . . **Brea Chemical, Inc.** (Union Oil of California subsidiary) will lease and operate specially-designed $13 million ammonia plant to be built by non-affiliated Amonaico Corp. on 30-acre site at Brea. Ammonia will be made from natural gas from Brea wells and plant will be built by C. F. Braun Co. Completion is scheduled for the summer of 1954.

. . . **Sinclair Refining Co.** has commenced operating its 21-tons per day sulfur unit, which recovers better than 90% of the elemental sulfur present in refinery gas feed stock, at its Marcus Hook, Pa. refinery. Product is stored molten in a 125-ton underground tank, pumped into tank trucks for delivery to consumers.

. . . **Standard Oil Co. of Calif.** has completed the largest Platformer installation yet built, its 12,000 b/d unit at the El Segundo refinery. According to Universal Oil Products Co., process licensor, Standard's unit will operate blocked, producing and aromatics concentrate half the time and high octane motor fuel for the balance. Estimated yields are 10720 b/d debutanized motor fuel and 8740 b/d of aromatic concentrate.

. . . **Gulf Oil Corp.** has completed a new 61-tons per day sulfur recovery unit at its Port Arthur, Texas refinery. Unit recovers sulfur from refinery gases, and has been designed to permit future expansion that would double present capacity. Product sulfur is converted into sulfuric acid within the refinery.

. . . **Six petrochemical expansion goals** are still unfilled, according to National Production Authority. The chemicals and the amounts of production capacity expansion eligible for rapid tax amortization certifications are:

Naphthalene—17,000,000 lbs.
Glycerin—35,000,000 lbs.
Tetraethyl lead chemicals (ethyl chloride and ethylene dibromide)—33,000,000 lbs.
Octyl alcohol—8,000,000 lbs.
Methylene chloride—6,000,000 lbs.
Nitrogen (combined form)—152,000 tons.

Markets, Prices

. . . **The "Seller's Market" began to disappear** in the last month of '52, according to many trade sources, after having prevailed for many refined oils throughout most of the year. With few exceptions, there were accelerated efforts on the part of sellers to find buyers for refined products and sour crudes. Some major sources went so far as to say they anticipated oversupply of light and heavy fuels as well as specialty products. There had been indications of supply excesses in the latter for several months.

. . . **Weakness in lubricating oils and waxes** was especially pronounced as December ended with prices for solvent refined lubes down sharply both for the month and from their mid-summer highs. Solvent refined oil in the Mid-Continent for domestic shipment declined in amounts ranging up to 3c a gal. in the last month of the year, with bright stock quoted upward from 27c and 200 vis. neutral upward from 16.5c, FOB Tulsa basis. Export prices at the Gulf dropped 2.5 to 3c with solvent bright at 26.5c and 200 vis. neutral at 15c; at these levels prices were 7.5 to 8c a gal. below those prevailing throughout most of the summer.

Trade sources reported a dwindling list of products for which refiners could sit back and wait for buyers. Avgas was still short, and gas oils and kerosine remained in good demand in the Gulf-Caribbean area. For the rest, however, both producers and refiners were on the lookout for new business.

. . . **Warmer than normal weather** for the winter to date, industrial demand for heavy fuel oil below expectations, and a sharp decline in ocean going transportation rates late in December, combined to dissipate the firming trend which had been apparent in both light and heavy fuels early in the month. While quoted prices generally remained unchanged, sellers more and more were resorting to "discounts" to stimulate open market shipments.

. . . **A large East Coast refiner** entered the Persian Gulf market for crude oil for the first time. Arrangements were completed for purchase of approximately 50 million bbls. of Kuwait crude for delivery to the Philadelphia refining district, according to trade reports. The major buyer involved reportedly has contracted to lift oil in the Persian Gulf at the rate of about 25,000 b/d over a 5-yr. period beginning Jan. 1, 1953.

Foreign

. . . **Daikyo Oil Co.**, Tokyo, has concluded agreement through World Commerce Corp. with Houdry Process Corp. for installation of a 4200 b/d Houdriflow catalytic cracking unit at Daikyo's refinery at Yokkaichi, Japan. Houdry reports unit will be the first installed in the Orient.

. . . **American Caltex Oil Group** is raising 2,400,000 sterling (about $6,720,000) to help finance its $70 million refinery at Kurnell, Botany Bay, New South Wales. Money will pay for material and equipment bought in Britain for refinery, which will have a capacity of about 20,000 b/d and should be completed sometime in 1954.

. . . **Arabian American Oil Co.** will install American Development Corp.'s electrolytic caustic regeneration process in connection with Arabian's 20,000 b/d treating plant at its Ras Tanura refinery, according to announcement from American Development.

. . . **Australasia Petroleum Refinery, Ltd.**, has been formed by Anglo-Iranian Oil Co. in connection with 60,000 b/d Kwinana plant AIOC is building near Fremantle, Western Australia.

. . . **Porte Marghera** refinery in Venice, Italy, jointly owned by Anglo-Iranian Oil Co. and Azienda Generale Italiana Petroli, has placed on stream its new 6750 b/d thermal reforming unit (See What's Happening, Oct. '50, p. 1020).

How porous *do you want your* catalyst supports?

Norton catalyst supports come in two types:

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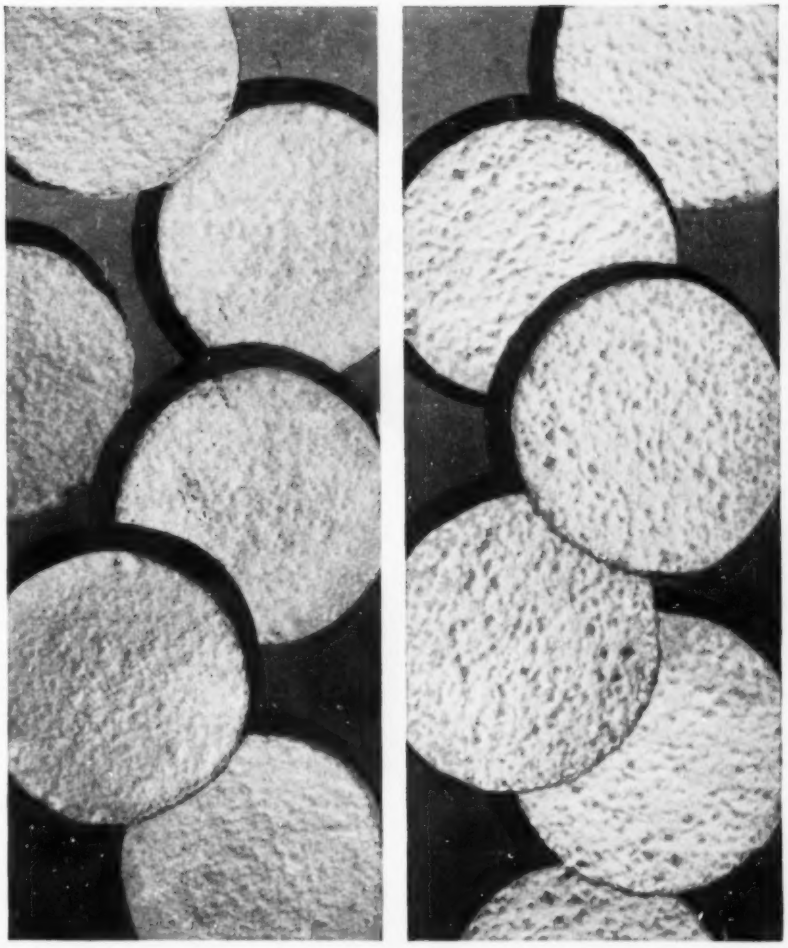
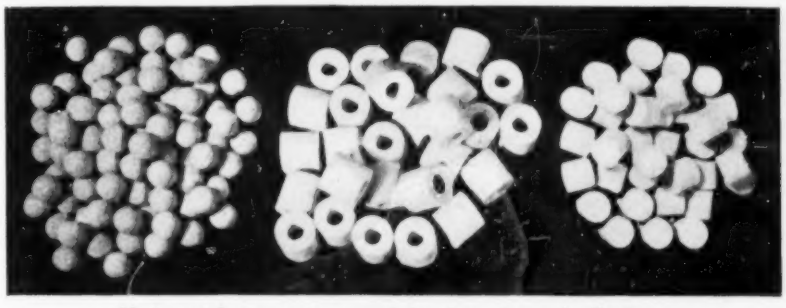


Greatly enlarged views of the two types of Norton catalyst support spheres. *Left: Norton Medium-Porosity Spheres* have pores close to surface. *Right: Norton High-Porosity Spheres* have connected pores throughout. You can also get Norton Low-Porosity Spheres if required.



Norton catalyst supports are made in sphere, ring, and pellet form.

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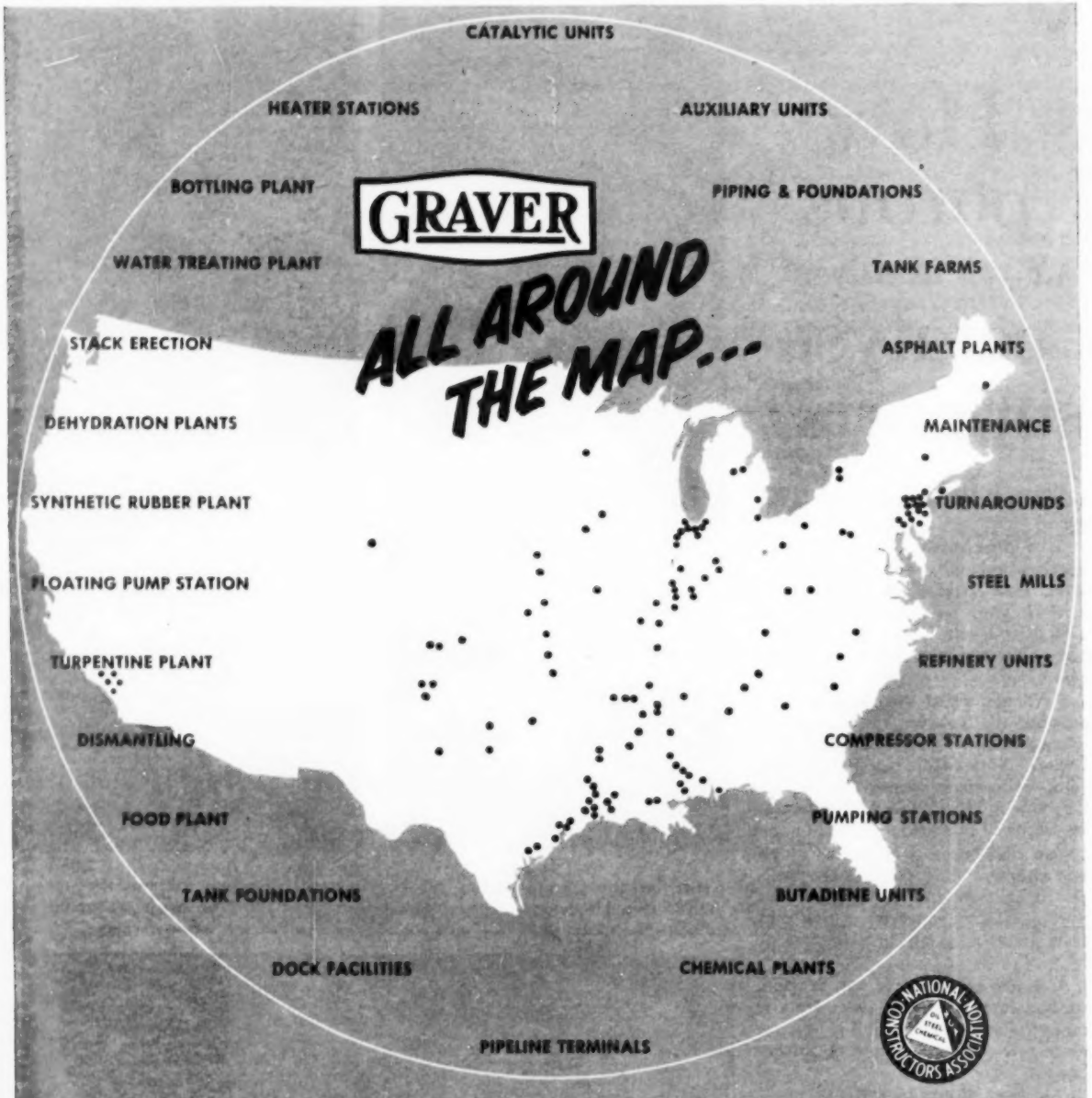
(To obtain more data on advertised products see page 128)



GRAVER INDUSTRIAL CONSTRUCTION OF ALL TYPES

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GRAVER

Reducing Quality Giveaway By Multi-Testing Products

IT HAS long been common practice for refiners to sell their products on quality tests of only a small fraction of the total production. Samples amounting to a few cc's or 5 to 10 gallons from tankage of 1000 to 100,000 bbls. are tested one or more times by a given test method and the contents of the tank sold by the refiner and accepted by the consumer on the basis of the tests on these small samples. Product quality has been made high so that poor testing in the laboratory left sufficient tolerance to make certain the product was up to specification. It is acknowledged that this quality giveaway costs the refiner considerable money.

Following the war, the Committee on Analytical Research of the American Petroleum Institute devised new tests and revised old tests used by refiners in their operations, to make their processing more efficient. The tests were evaluated according to their ability to measure the desired product of the property, time required for the execution of the test, the cost of conducting the test and the precision of the results obtained. These improvements, particularly in reproducibility, gave refiners a more accurate basis for comparing results.

The next logical step, now being taken by some refiners, is to make multiple tests on a given product to reduce the former large allowance for testing error where quality was determined by possibly only one test. This has the effect of reducing the manufacturing tolerance necessary to be assured of meeting specifications, and elimination of excessive giveaway.

Humble Oil & Refining is one company which has worked out a technique for product multi-testing.(1) "At some balance point between excessive testing costs and excessive product quality giveaway minimum refinery operating costs can be achieved" it is stated. The paper presents a discussion of factors affecting the application of multi-testing to approach this optimum point. Although illustrated for the octane number of motor gasoline, the method used by Humble is described as being general in nature, and the charts presented may be used for similar problems without the necessity of recomputing.

The Humble procedure applies multi-testing to the one or possibly two specifications which are critical on any product. "As an example" it is stated, "the critical specifications for aviation gasoline for the Armed services will probably be Aviation and Supercharge rich octane numbers. The other specifications imposed on the product, while necessary for its efficient performance in the field, are not difficult to meet, or have rather wide tolerance specified, and are almost automatically met when the critical specifications are satisfied."

By translating improved test results, through multi-testing, into reduced manufacturing tolerance necessary to be assured of meeting specifications, economics are presented on the optimum octane testing of motor gasoline, as an example. Results presented indicate optimum testing to range from 6 to 30 replicates, with savings ranging from $3.6 to $26.5/1000 bbls. of gasoline produced for assumed but reasonable unit costs. Quadruplicate testing permits realization of 50 to 85% of the saving obtained with optimum testing.

The use of multi-testing techniques offers distinct possibilities for refiners, through reducing their manufacturing tolerances to insure product specifications are met. The large amount of computations of test data which are required may provide new applications for the new high speed automatic calculating machines. —V.B.G.

(1) "Effect of Multi-Testing on Refinery Production Costs," by M. R. Morrow and C. T. Shewell, Refining Technical and Research Divisions, Humble Oil & Refining Co., Baytown, Texas. Presented at Group Session on Analytical Research, 17th Midyear Meeting, API Refining Division, San Francisco, May 12, 1952. *Industrial and Engineering Chemistry*, January, 1952.

Improving the Utilization of Engineering Manpower

PERTINENT to refining companies particularly is the subject of making better use of its engineering personnel. To this end valuable data will be found in the report of a survey made by the National Society of Professional Engineers.(1)

The report is the second of a series of Executive Research Surveys begun in 1951 by the Society, through its Professional Engineers Conference Board for Industry. An oil company executive, G. W. McCullough, general manager and vice president, Phillips Chemical Co., is a member of the Board and among its representatives also are men with design and construction engineering firms and other types of companies which, like petroleum, have turned to professional personnel to an increased extent in the past decade or so. The report pools the experience of more than 495 companies employing engineers, on techniques for making more efficient use of these workers. The methods and procedures they found helpful point the way for other companies faced with the same problems.

Indoctrination programs for newly-hired engineers are important in making them more efficient and more effective in their work. Many companies have intensified and accelerated their training program while still maintaining the high quality of the training, it is reported. Centralization of top-level engineering and clear cut delegation of authority and responsibility has been found another means for making engineers more effective. Training in human relations and supervisory techniques enables engineers to direct the work of the non-professional personnel to better advantage.

Better original planning of work has been found by a number of companies to result in better use of technological manpower. More thought can be given to the selection of subordinate personnel from shop workers and students who have studied some engineering but have not completed their courses; also to the training of this personnel in company or technical schools. Increased standardization and work simplification open many sub-professional jobs to non-engineers and thus lighten the engineering workload.

Individual assignments should be reviewed, the report advises, to determine if they provide for the engineer making his best contribution to the company and afford the best opportunity for his talents.

More than half the companies participating in the survey reported the use of auxiliary sources of engineering talent to lighten the load on their own forces. Incentives to the individual have been found more helpful in retaining engineering staffs than are insurance and hospitalization benefits. Engineer utilization checklists are used to determine from the engineers themselves what routine tasks and subordinate work they are doing that could be done by non-professional personnel.

It is now generally accepted that industry's need for engineers will not be entirely alleviated by increasing the number of engineering students in our schools. Oil companies may find it profitable to review their programs to make more efficient use of their technological personnel for an indefinite future period. —V.B.G.

(1) Executive Research Survey No. 2, "How to Improve the Utilization of Engineering Manpower," National Society of Professional Engineers, 1121 Fifteenth St., Northwest, Washington 5, D. C.

Here to Stay, Plastic Piping Has a Two-fold Interest for Petrochemicals

THE tremendous growth in plastic and plastic-coated piping should be of considerable interest to the petroleum and petrochemical industry—from the standpoint of users as well as raw material producers.

Plastic pipe consumed about 5 million lbs. of resin (usually synthetics) in 1951, but prediction is that production of such piping will reach 75 million lbs. in another 10 years. This is still only a small proportion of total piping consumption, however; which in 1949 was 7 million tons of steel and 1.5 million tons of cast iron pipe.(1)

Phenol-formaldehyde resins, for example, are sprayed on the inside of concrete, glass, or metal pipe and baked at 400° F. They set to a very hard finish and are especially useful for many types of corrosive solutions, including 60% sulfuric acid at up to 225 and 400° F.

Vinyl-vinylidene chloride polymers as pipe liners provide good corrosion resistance between −40 and 194° F., and have high mechanical strength. Used alone as flexible tubing they may fracture at under-freezing temperatures, but gas companies have been using short lengths for some portions of their distribution systems. This type of plastic pipe is the most expensive, running $2.49/ft. for 2-in. pipe.

The furan types are paraffin-deposit resistant. They're useful for carrying crude oil, gases, and refined oil products. In one case, where conventional pipe carrying sour crude lasted only six months, furan-lined pipe has been satisfactory for 21 months, and is expected to last three more years.

Styrene plastics are viewed as a major potential in piping. Styrene-acrylonitrile is particularly useful for carrying petroleum and its products. Likewise, it can handle corrosive chemicals like chlorine and its compounds. Another material showing great promise in acid, alkali, and solvent handling is the unplasticized polyvinyl chloride, which is extruded into standard pipe and tubing sizes. Still other well-known materials include cellulose acetate-butyrate and the polyethylene piping.

Important point to remember in investigating plastics as piping material; each has a specific advantage in certain properties and also specific shortcomings in others. There is no general-purpose plastic pipe. Obviously, then, production and consumption of metal pipe will not become zero quantities at any time in the foreseeable future. At the same time, special jobs with tough requirements in specific fields can often be best filled by plastic. Hence, the continued growth and predicted boom in plastic piping.

—W.C.U.

(1) *Industrial Bulletin* of Arthur D. Little, Inc., Dec., 1952.

Tomorrow's Successful Engineer— How Will He Think and Act?

DEALING with people will continue to take an increasingly important place in the overall thinking and knowledge and skills of the engineer of the future. This fact was made self-evident by the intense interest of members of the American Institute of Chemical Engineers in a symposium on the subject of human relations at the Institute's annual meeting in Cleveland last month.(1)

While the remarks of symposium speakers were directed to human relations in the chemical industry, it is obvious that all phases of the process industries can expect to see greater attention paid to this problem in the future. The need for understanding human factors has resulted from two major trends, according to R. L. Demmerle of General Aniline & Film Corp. Technical men must become "ambassadors" to the lay world, he said, because:

1—they are moving into management positions where the principal responsibility is to direct people.

2—non technical groups and the investing public are becoming more interested in the chemical industry.

Successful engineers of the future will be those who have developed well-rounded "MAP's". A MAP, it was explained by R. S. Schultz, a consulting industrial psychologist, represents a combination of three characteristics—motivation, ability ,and personality. Too many engineers today are lop-sided. Their motivation and ability are superior. Yet they pay too little attention to personality.

Tomorrow's leaders in engineering will be men who learned to know themselves, who admit their own strengths and weaknesses and do something about it. Secondly, they will have learned to appeal to the selfish interests of others in getting things done. Thirdly, they will know how to put themselves in the "other man's shoes." Fourthly, they will have profited by studying and imitating their successful superiors.

Points brought out by other symposium speakers included: 1) the future engineering success will be more aware of the problems of general management in dealing with people, and 2) he will be capable of expressing himself, of putting ideas across in plain language. He will not use long, complex technical words and sentences.

For example, instead of saying, "Because of the potential hazard and ever-present possibility of process upsets due to improper temperature control, it is extremely important that the reaction temperature be maintained in the range of 175-180° F." he will say, "Keep that thermometer pointer between 175 and 180." —W.C.U.

(1) Symposium on Human Relations, 45th annual meeting, American Institute of Chemical Engineers, Cleveland, Ohio, December 7-10, 1952.

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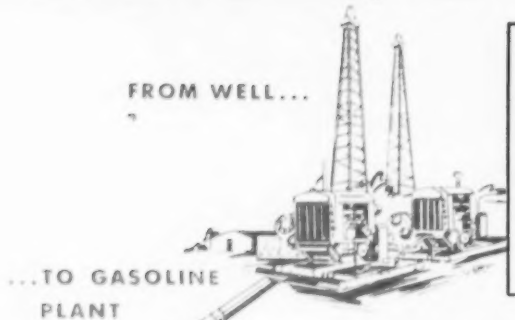

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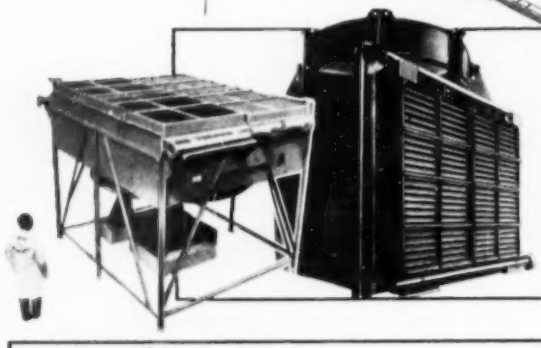

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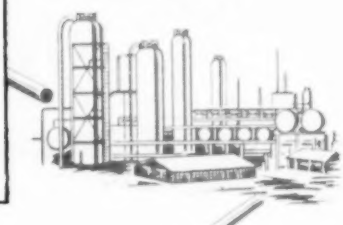

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Letters

Saving Critical Alloys

. . . On behalf of the Committee, I would like to express appreciation for the publicity given the two reports in PETROLEUM PROCESSING. ["How to Save Those Critical Alloys," Dec., 1952, p. 1776, a summary of the reports of the Refining Section of the API Interim Advisory Committee on Alloy Steels]. This was a very effective way of advising the industry concerning the work of this committee.

It is very difficult to visualize the possible effects now of decontrol on critical elements. Nickel is still in short supply and probably will remain so for some time to come. The other elements are much less critical than a year ago. It appears, therefore, that the industry may expect to be able to obtain increasing tonnages of alloy steels on the basis of the recommendations made by the committee. . .

Blaine B. Wescott
Associate Director
Gulf Research & Development Co.
Pittsburgh, Penna.

● Thank you, reader Wescott. Mr. Wescott is chairman of the Interim Advisory Committee.

More on Engine Wear

(The article "Friction—Main Cause of Engine Wear" in the September issue of PETROLEUM PROCESSING *brought forth considerable criticism of that theory, which criticism was published in the form of letters from our readers in the October issue. J. F. Kunc, Jr., Research Division, Esso Laboratories of Standard Oil Development Co., and one of the authors of the paper on which the September article was based, has made a general reply to the criticism.—Editor)*

We read the letters which appeared in the October issue of PETROLEUM PROCESSING regarding the article on engine wear in the September issue with a great deal of interest. We wish to take this opportunity to thank the authors of these letters for their comments.

From the tenor of the letters submitted it is quite evident that the question of the mechanism by which engines wear out during actual service in the field is a very controversial one. This is not surprising, considering the vast number of types of engines involved and the operating regimes to which they are subjected. The fact that engine wear is such a controversial subject is an indica-

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In Honeywell's shop devoted exclusively to panel production, skilled workmen do a complete assembly job. Every instrument, controller and accessory is mounted in place. All back-of-panel wiring and piping is completed, so the board is ready to connect to plant equipment. Before shipment, the entire panel goes through rigorous tests to assure trouble-free installation and start-up when the panel reaches its destination.

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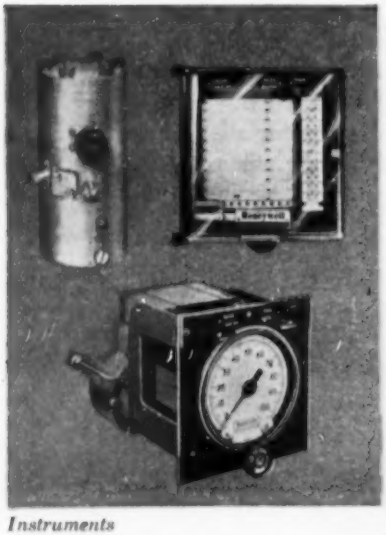
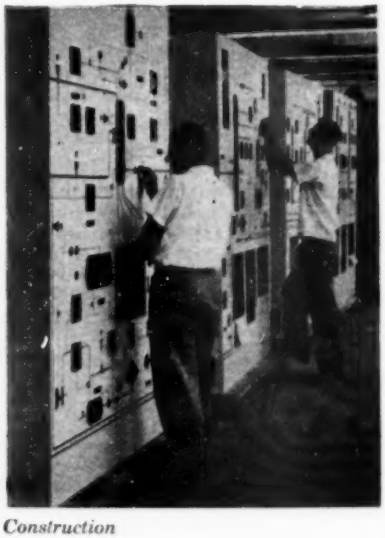


Instruments

Design



Construction

MORE THAN *50 Tel-O-Set Indicators and Recorders are mounted on this Honeywell graphic panel. The section shown here includes temperature, pressure, flow and liquid level controllers for a coking unit.*

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tion that it is not thoroughly understood and has not been studied as well as it might be. This should serve as a stimulus to promote additional research in this very important field by the petroleum industry as well as by the metallurgists and the engine builders.

Considerable research effort has been devoted during the last dozen years or so toward improving the oxidation, bearing corrosion and sludge handling characteristics of motor oils. As a result, engine wear has now become a more important factor than engine sludge and varnish formation in limiting the life of engines between overhauls.

As pointed out in the paper "How Engines Wear", on which the article "Friction—Main Cause of Engine Wear" was based, careful examination of a very large number of gasoline engines operated in the field has led us to believe that friction and abrasion rather than low temperature corrosion are responsible for the greater part of the wear occurring in the bulk of the engines in the field. This does not imply that corrosion can be completely discounted as being one of the important factors influencing engine wear. Since corrosive wear can and does occur in engines in certain types of service, it must be taken into consideration when formulating motor oils which will minimize engine wear. This type of wear is combatted rather effectively by the detergent-inhibitor type additives now being used extensively in motor oils. In spite of this improvement, engine wear still continues to be a problem.

The real question then resolves itself down to what is needed to make even better crankcase oils from a wear resistance standpoint so that engines in service will last longer between overhauls. In our own research on this problem we are continuing to investigate both the mechanical and chemical aspects of engine wear. At the present time, we are assuming that the mechanical factors involved are more important than the chemical factors. In other words, the engine surfaces must be more adequately protected against physical contact rather than against chemical attack. Subsequent events may prove this hypothesis to be untenable, or at least require modification. However, based on our experience with other similar problems, we feel that the engine wear problem will be solved most rapidly by setting up hypotheses concerning the mechanism of engine wear based on the best available knowledge and then testing the validity of these hypotheses.

J. F. KUNC, Jr.

Research Division
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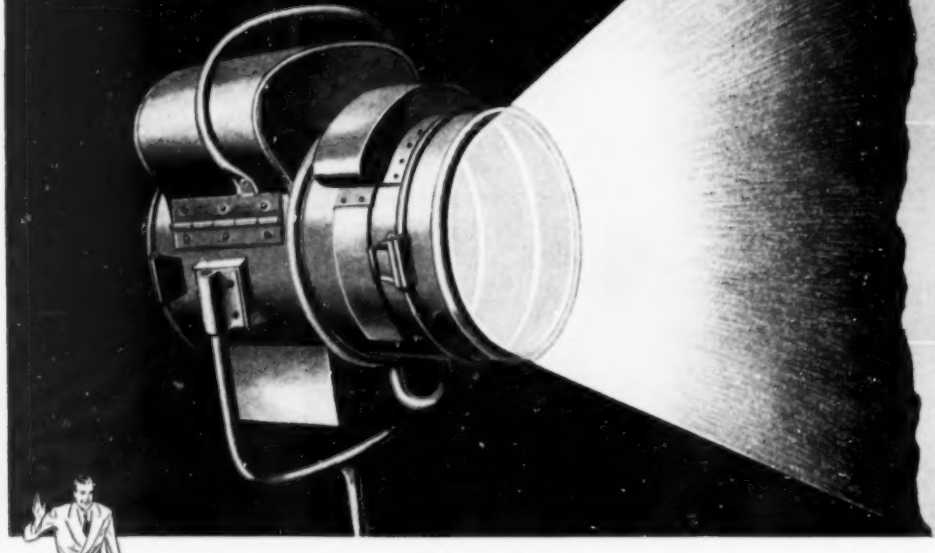

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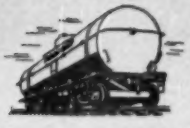

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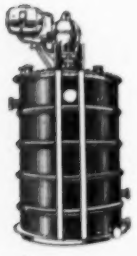

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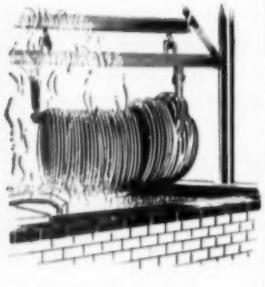
Autoclaves

Agitators



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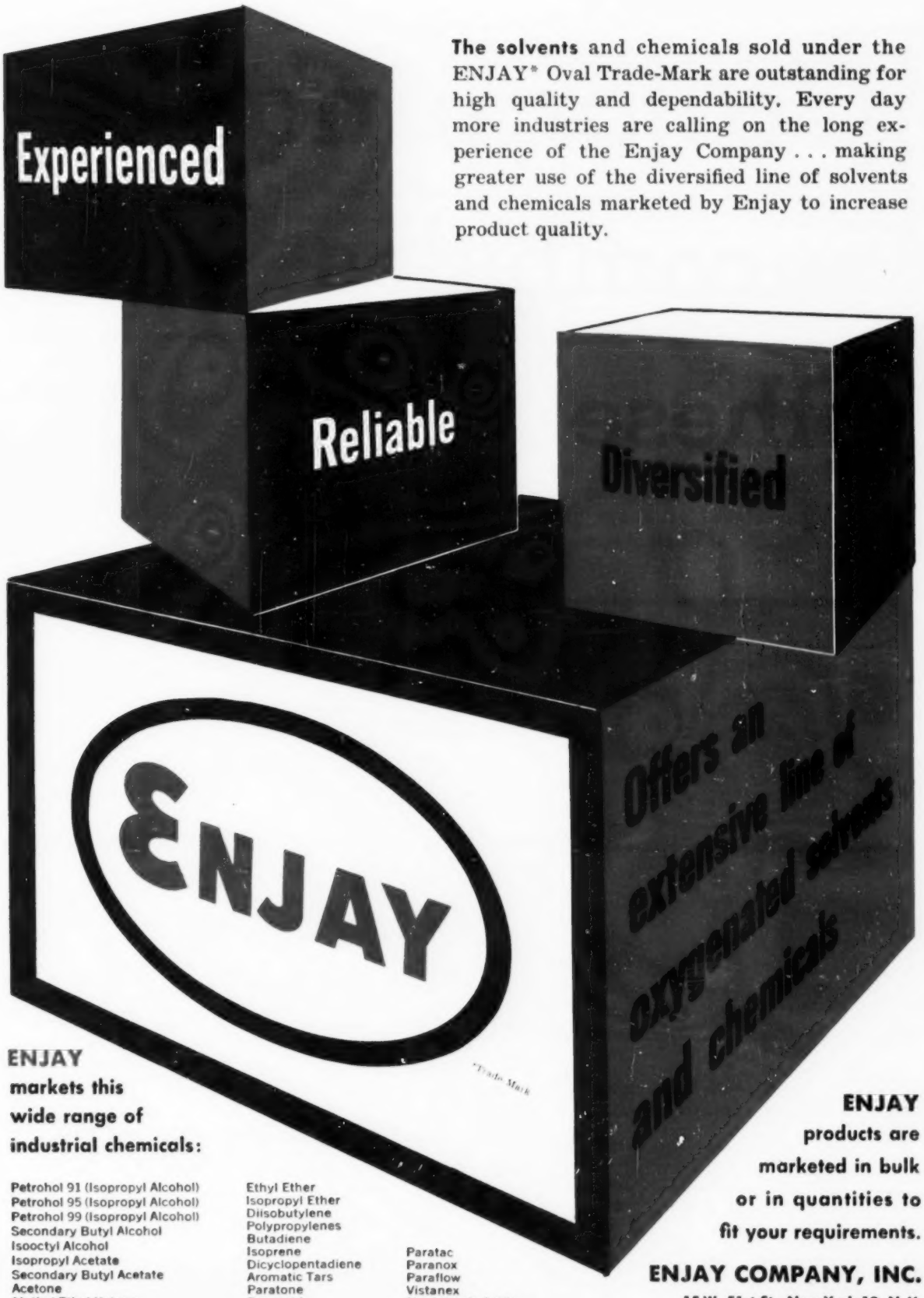
USE SHEET OR PLATE OF	FOR RESISTANCE TO
HASTELLOY Alloy B (nickel-molybdenum-iron)	Hydrochloric acid, wet hydrogen chloride gas, sulphuric acid, phosphoric acid, organic acids, high temperatures.
HASTELLOY Alloy C (nickel-molybdenum-chromium-iron)	Nitric acid, free chlorine, acid salts, hydrochloric acid, sulphuric acid, phosphoric acid, organic acids, sulphurous acid, high temperatures.
MULTIMET Alloy (cobalt-chromium-nickel-iron)	Oxidation, high temperatures.
HAYNES Alloy No. 25 (cobalt-chromium-tungsten-nickel)	Oxidation, high temperatures, carburization, wet chlorine, nitric acid.

HAYNES TRADE-MARK *alloys*

Haynes Stellite Company
A Division of
Union Carbide and Carbon Corporation
UCC
General Offices and Works, Kokomo, Indiana
Sales Offices
Chicago — Cleveland — Detroit — Houston
Los Angeles — New York — San Francisco — Tulsa

"Haynes," "Hastelloy," and "Multimet" are trade-marks of Union Carbide and Carbon Corporation.

(*To obtain more data on advertised products see page* 128)



The solvents and chemicals sold under the ENJAY* Oval Trade-Mark are outstanding for high quality and dependability. Every day more industries are calling on the long experience of the Enjay Company . . . making greater use of the diversified line of solvents and chemicals marketed by Enjay to increase product quality.

ENJAY markets this wide range of industrial chemicals:

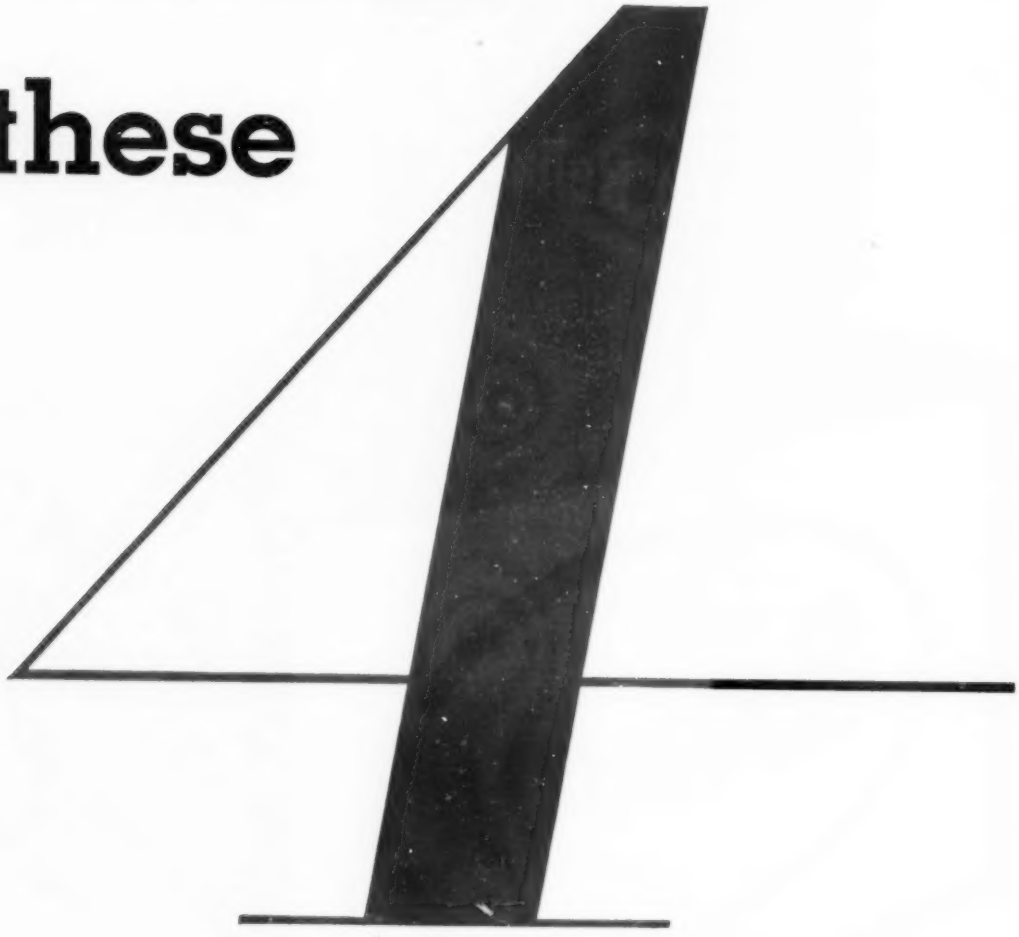
Petrohol 91 (Isopropyl Alcohol)
Petrohol 95 (Isopropyl Alcohol)
Petrohol 99 (Isopropyl Alcohol)
Secondary Butyl Alcohol
Isooctyl Alcohol
Isopropyl Acetate
Secondary Butyl Acetate
Acetone
Methyl Ethyl Ketone
Ethyl Ether
Isopropyl Ether
Diisobutylene
Polypropylenes
Butadiene
Isoprene
Dicyclopentadiene
Aromatic Tars
Paratone
Parapoid
Paratac
Paranox
Paraflow
Vistanex
Naphthenic Acids

ENJAY products are marketed in bulk or in quantities to fit your requirements.

ENJAY COMPANY, INC.
15 W. 51st St., New York 19, N. Y.

(To obtain more data on advertised products see page 128)

Catforming combines these



advantages

(To obtain more data on advertised products see page 128)

The Atlantic Catalytic Reforming Process brings you:

1. high yield

The Atlantic Catforming Process was specially designed to produce high octanes at high yields. It properly balances all the many reactions necessary for the production of high octanes, assuring you of a high yield-octane relationship and maximum liquid recovery of high octane products from any feed stock.

2. low cost

Catforming units can be designed by *your own* contractor, thus providing important economies and greater simplicity. Commercial units of from 750 to 12,000 BPD charge capacity are now being built at investment costs of only $250 to $400 per barrel. In operation, no feed preparation, product finishing or costly regeneration facilities are needed.

3. stability

The catalyst in the Atlantic Catforming Process retains reforming activity for extensive periods, and at the same time has no loss in selectivity. Even under the varied conditions encountered in normal refining operations, catalyst life is from 35 to 100 barrels per pound.

4. ruggedness

Activity and selectivity of the Catforming catalyst are virtually unaffected by water, sulphur compounds, and nitrogen compounds normally encountered in naphtha reforming. Atlantic's catalyst has *proved* its ability to resist physical and chemical change.

FOR COMPLETE DETAILS call or write The Atlantic Refining Company, Research and Development Dept., P. O. Box 8138, Philadelphia 1, Pa. (Telephone, Howard 5-2345.)

It's the catalyst that counts

ATLANTIC

name your refinery equipment needs

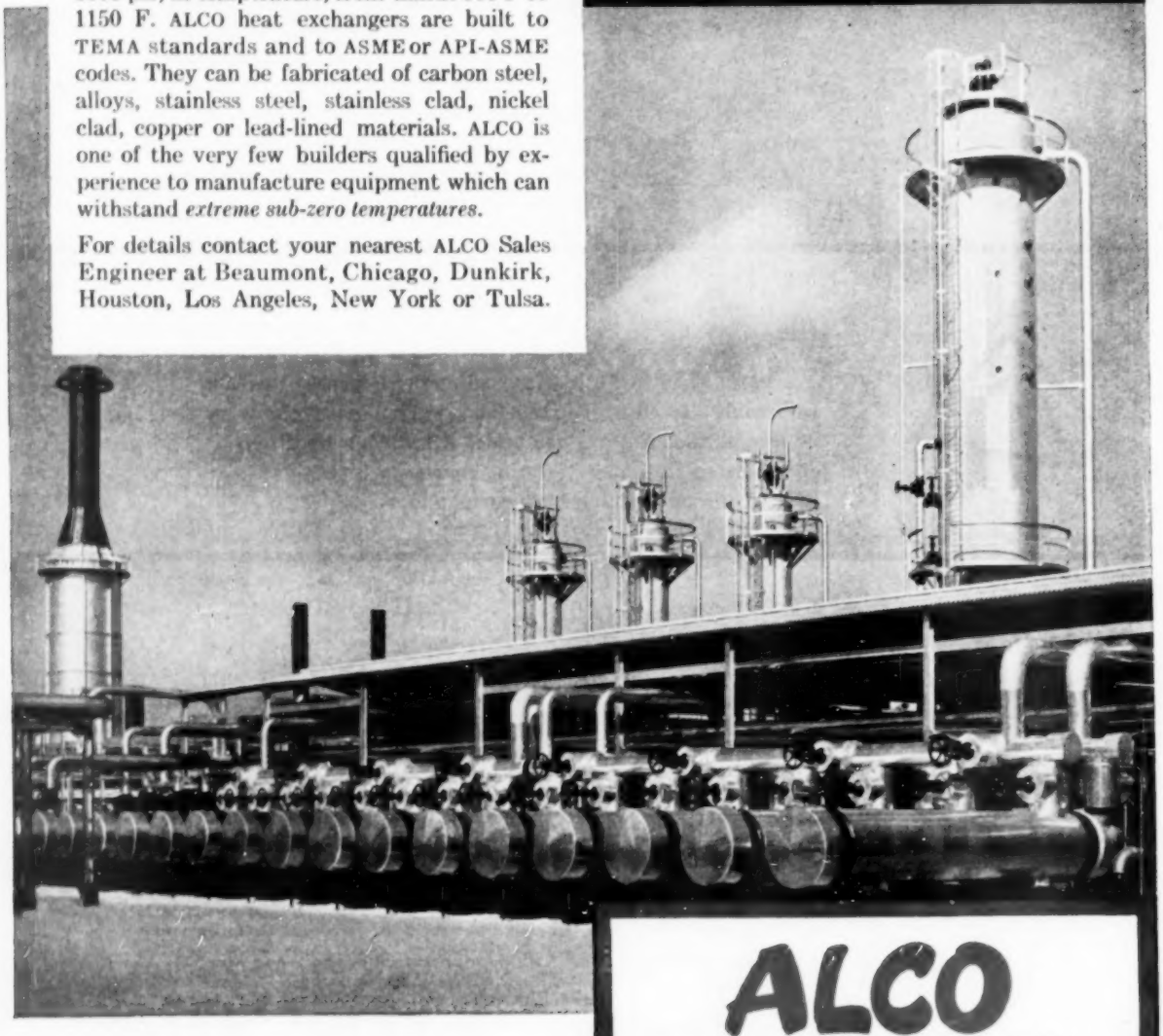
Custom engineering . . . that's the secret of ALCO's success at meeting virtually all of the refining industry's many equipment requirements.

Rugged ALCO products have been produced to cover an extremely wide range of requirements. Units vary in diameter from four inches to twelve feet; in weight, from 100 to 300,000 pounds; in pressure, from high vacuum to 3000 psi; in temperature, from minus 300 F to 1150 F. ALCO heat exchangers are built to TEMA standards and to ASME or API-ASME codes. They can be fabricated of carbon steel, alloys, stainless steel, stainless clad, nickel clad, copper or lead-lined materials. ALCO is one of the very few builders qualified by experience to manufacture equipment which can withstand *extreme sub-zero temperatures.*

For details contact your nearest ALCO Sales Engineer at Beaumont, Chicago, Dunkirk, Houston, Los Angeles, New York or Tulsa.

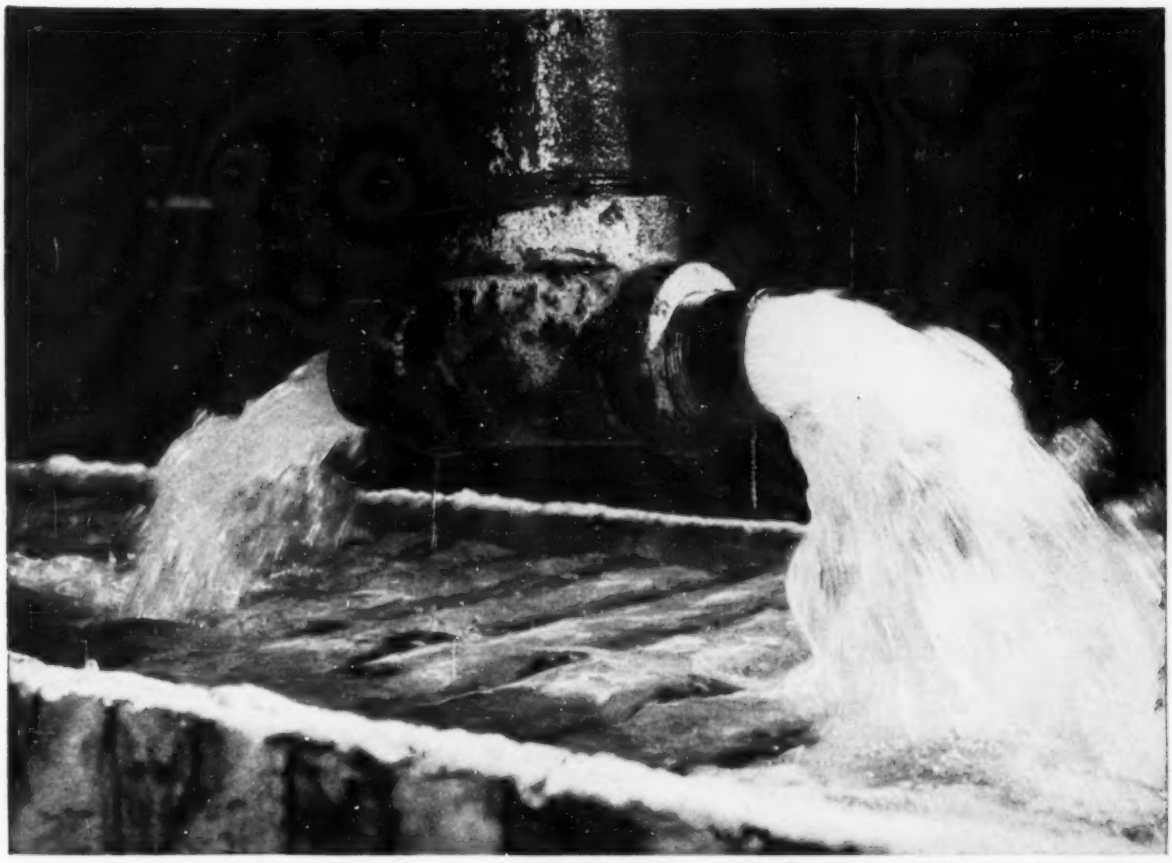
piping
pressure vessels
heat exchangers
product filters

ALCO can meet them



ALCO

ALCO PRODUCTS DIVISION
AMERICAN LOCOMOTIVE COMPANY
Dunkirk, N. Y.



LIQUID WAX pours into a mold at Esso Standard Oil's Bayonne (N. J.) Refinery.

Solvent extraction at 200,000,000 lbs a year

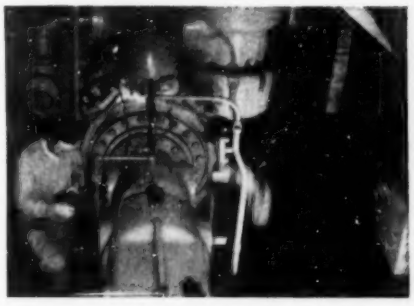
The Esso Standard Oil Company's Bayonne (N. J.) Refinery dewaxes oils by solvent extraction of chilled charge stocks. This process enables Esso to produce up to 200,000,000 lbs of oil-free wax and up to 1,000,000 gallons of wax-free lubricating oils every year.

Vital *chilling* used in this MEK dewaxing process is provided for by Worthington equipment including 3 ammonia compressors, 6 chilling machines, 6 exchangers, 3 centrifugal pumps, 2 instrument air compressors and 1 high-volume pump handling anhydrous ammonia.

As a user of Worthington refrigeration equipment, Esso is part of a long list of "big-name" Worthington users. Others include: E. I. Du Pont de Nemours & Co., Edgemore, Del., Orange, Tex.; Minnesota Mining and Manufacturing Co., St. Paul, Minn.; Shell Chemical Co., Houston, Tex.; Standard Oil Co. of California, Richmond, Calif.; Sinclair Refining Co., Houston, Tex.; Tidewater Oil Co., Bayonne, N. J.

The advantages that go along with the Worthington name are known the world over. No other manufacturer makes so complete a line. And every Worthington system is Worthington-*made*, not just Worthington-assembled — assuring you of perfectly balanced operation and unit responsibility.

Worthington Corporation, Air Conditioning and Refrigeration Division, Harrison, New Jersey.



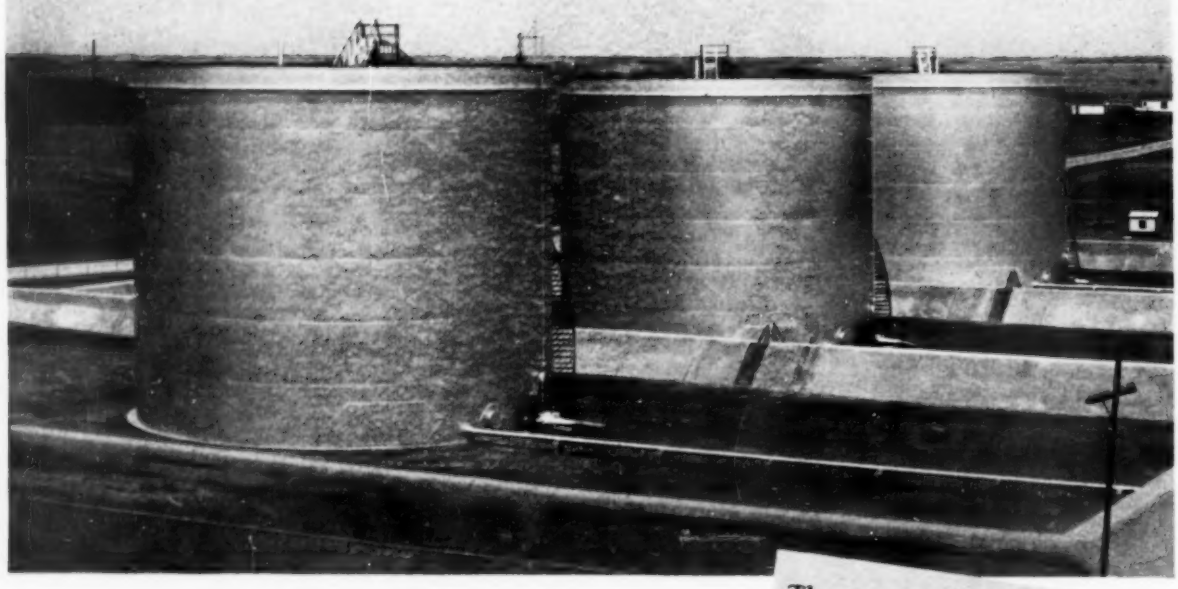
PARTIAL VIEW of one of the three Worthington Balanced Opposed Ammonia Compressors (27½/16½ x 15: 900 hp), part of the Worthington equipment used at MEK plant at the Bayonne (N. J.) refinery of Esso Standard Oil Company. A-2.32

WORTHINGTON

Air Conditioning and Refrigeration

(To obtain more data on advertised products see page 128)

REDUCING EVAPORATION LOSSES according to plan



THE three 24,000-bbl. Horton Double-Deck Floating Roof tanks shown above, a 6-ft. by 20-ft. separator, an elevated water tank, a 10,000-bbl. flat-bottom water tank and three Hortonspheroids are helping the Elk City, Oklahoma, crude oil and gas processing plant operated by Shell Oil Company obtain maximum production from the Elk City field.

The three tanks store high gravity crude more efficiently because Horton Double-Deck Floating Roofs float directly on the liquid. As a result, filling losses are prevented, the fire hazard is cut down and corrosion on the underside of the roof is greatly reduced. Also instrumental in the efficient operation of Horton Double-Deck Floating Roofs is the improved Horton Seal that prevents the escape of vapor around the edge of the deck.

Take advantage of these important savings in your storage operation by writing our nearest office for information on Horton Double-Deck, Pontoon or Pan type floating roofs. There is no obligation on your part.

The Elk City plant, which is operated by Shell Oil Company for the nine operators and over 500 royalty owners in the Elk City field, is processing 15,000 bbls. of crude oil per day and recovering 225,000-gals. of natural gasoline and butane mixture and 55,000-gals. of propane per day. Unitization of the field is employed to assure maximum production and efficiency.

CHICAGO BRIDGE & IRON COMPANY

Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY, and GREENVILLE, PENNSYLVANIA

Atlanta 3 ..... 2103 Healey Building
Birmingham 1 ..... 1527 North Fiftieth Street
Boston 10 ..... 1029—201 Devonshire Street
Chicago 4 ..... 2114 McCormick Building
Cleveland 15 ..... 2215 Midland Building
Detroit 26 ..... 1532 Lafayette Building
Havana ..... 402 Abreu Building
Houston 2 ..... 2130 C&I Life Building
Los Angeles 17 ..... 1526 General Petroleum Building
New York 6 ..... 3310—165 Broadway Building
Philadelphia 3 ..... 1630—1700 Walnut St. Building
San Francisco 4 ..... 1559—200 Bush Street
Seattle 1 ..... 1330 Henry Building
Tulsa 3 ..... 1620 Hunt Building

REPRESENTATIVES AND LICENSEES

Horton Steel Works, Fort Erie, Ontario, Canada
Ateliers et Chantiers de la Seine Maritime, Paris, France
Constructions Metalliques de Provence, Arles-sur-Rhone, France
Chicago Bridge & Iron Company, Ltd., Apartado 1348 Caracas, Venezuela
Sociedade Chibridge de Construcoes Ltda., Av. Franklin Roosevelt, 194-S/704-C Rio de Janeiro, Brazil
Compagnia Tecnica Industrie Petroli, Rome, Italy
Whessoe Limited, Darlington, England
Motherwell Bridge & Engineering Company, Limited, Motherwell, Scotland
Comprimo N. V., 21, Amstel, Amsterdam (c) Netherlands

TYPE E turbines can handle it!

Spencer Chemical Company of Pittsburg, Kansas, has a total of ten 47-hp Type E turbines for driving blowers. Units are mounted outdoors on structural steel and are exposed not only to the elements, but to a corrosive ammonium-nitrate atmosphere.

Continued satisfactory operation of the turbines under these conditions is proof that the Type E can "take it" . . . proof that Type E construction keeps foreign matter out . . . proof that materials used resist corrosion and erosion.

Weather and corrosion resistance are important . . . in the chemical industry and in other industries as well. Important, too, are other Type E features, such as dual protection against overspeed, floating movement of governing and trip linkages, centerline support, parts interchangeability between wheel sizes. Outstanding Type E design assures safe, trouble-free, economical performance for long periods of continuous operation . . . or instant operation when used as a stand-by drive.

Other types in the complete Westinghouse general-purpose turbine line include heavy-duty and multistage units.

Get the facts from your nearby Westinghouse office, or write for twenty-page book B-3896. Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-50542

YOU CAN BE SURE...IF IT'S
Westinghouse
TYPE E Turbines

THESE TWO EXAMPLES SHOW YOU

What Nordstrom Means by "Lubricaut

Nordstrom three-way Transflo valves on relief service at top of propylene tower separating propylene from propane.

TYPICAL NORDSTROM REFINERY APPLICATIONS

- Catalytic Polymerization
- Crude Topping and Vacuum Distillation
- Fluid Catalytic Cracking and Gas Recovery
- Distillate Recovery in Cycling Plants
- Duo-Sol Solvent Extraction
- Houdriflow Catalytic Cracking and Gas Recovery
- Light Ends Fractionating
- Thermal Cracking
- Phenol Extraction
- Propane Deasphalting
- Cycloversion
- Delayed Coking
- Girbotol Process
- Propane Dewaxing
- Hydroforming Process
- Naphtha Polyforming
- Solexol Process
- Solvent Dewaxing
- Thermal Reforming

Nordstrom has compiled a series of specification sheets for each of these processes, showing recommended materials, pressure classes, lubricants and valve figure numbers. Ask your Nordstrom sales engineer to review them with you.

TYPICAL NORDSTROM PROCESS INDUSTRY APPLICATIONS

- Beverage Plants
- Cement Plants
- Chemical Plants
- Explosives
- Food Plants
- Gas Plants
- Ice and Refrigeration
- Paint and Lacquer
- Paper and Pulp
- Pharmaceuticals
- Power and Steam Plants
- Rubber Plants
- Sewage Plants
- Smelters and Mines
- Soap Factories
- Steel Mills
- Sugar Refineries
- Synthetic Ammonia
- Synthetic Fibers
- Synthetic Plastics
- Synthetic Rubber
- Tanneries
- Textiles and Dyes
- Water Works

The new Nordstrom Corrosion-Resistant Valve Bulletin V-217 will make it easy for you to fit the right valve to each service. Write for a copy, Rockwell Manufacturing Company, Pittsburgh 8, Pa., or ask your Nordstrom sales engineer.

-Sealed for POSITIVE SHUT-OFF"

Here are two typical Nordstrom valve process applications—one is a propylene tower, the other a dry hydrogen line.

They illustrate an important point in specifying valves for process service . . . if really tight shut-off of hard-to-hold gases or fluids is important, no valve can do the job better than Nordstrom.

Why? Because Nordstrom is the original lubricated plug valve. Nordstrom is the valve with the extra seal of plastic lubricant around the valve ports to check seepage of even the lightest, most penetrating substances.

That, of course, means greater safety, and greater economy, too, because when leakage is prevented, valve life is far longer. And most important, it means uninterrupted operation of continuous process units—no down-time for avoidable valve repairs.

The same lubricant that seals, also keeps the valve ready to operate in an emergency.

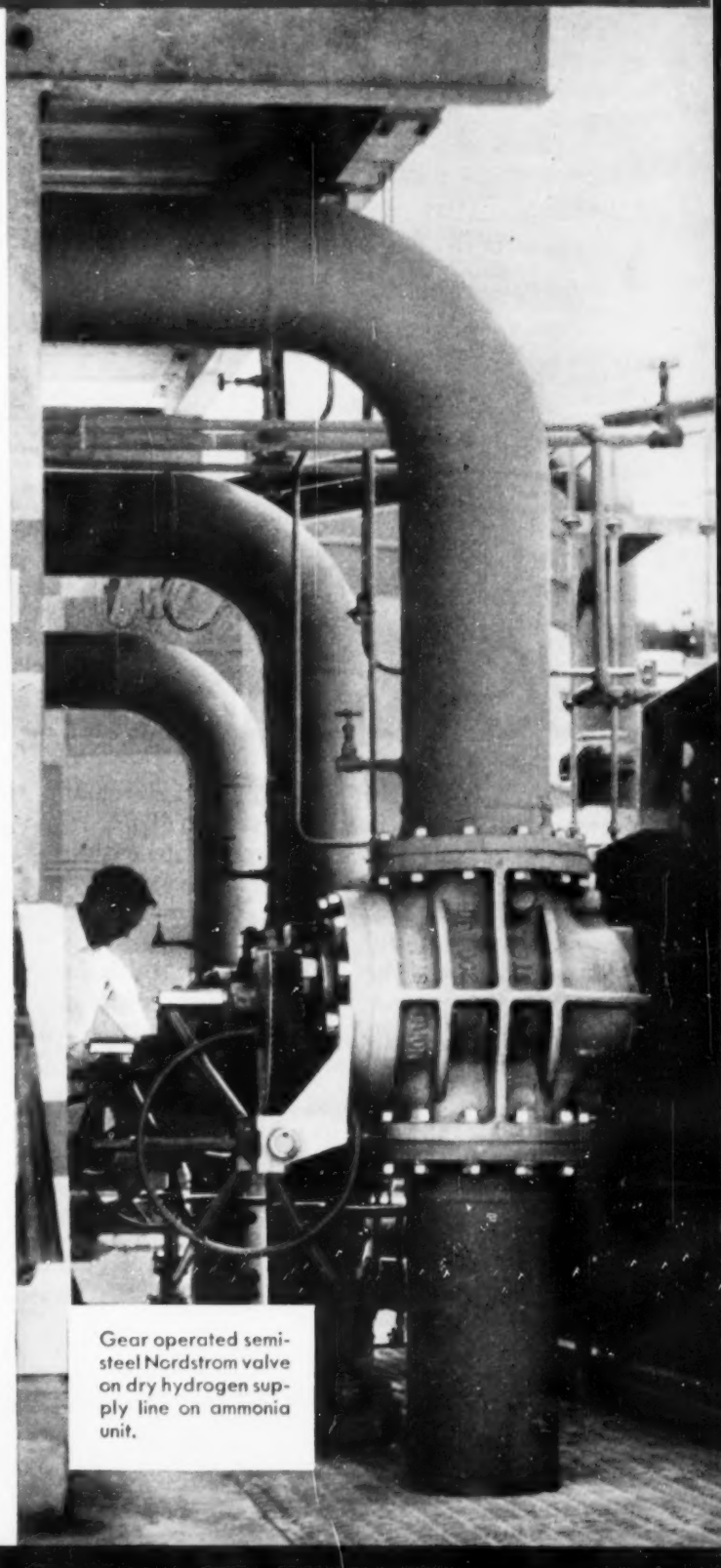
Nordstrom valves are built in a wide range of sizes, pressures, special metals and body designs for the process industries, including three- and four-way designs for batching, blending and switching. Rockwell Manufacturing Company, Pittsburgh 8, Pa.

ROCKWELL Built

Nordstrom Valves

Lubricant-Sealed for Positive Shut-Off

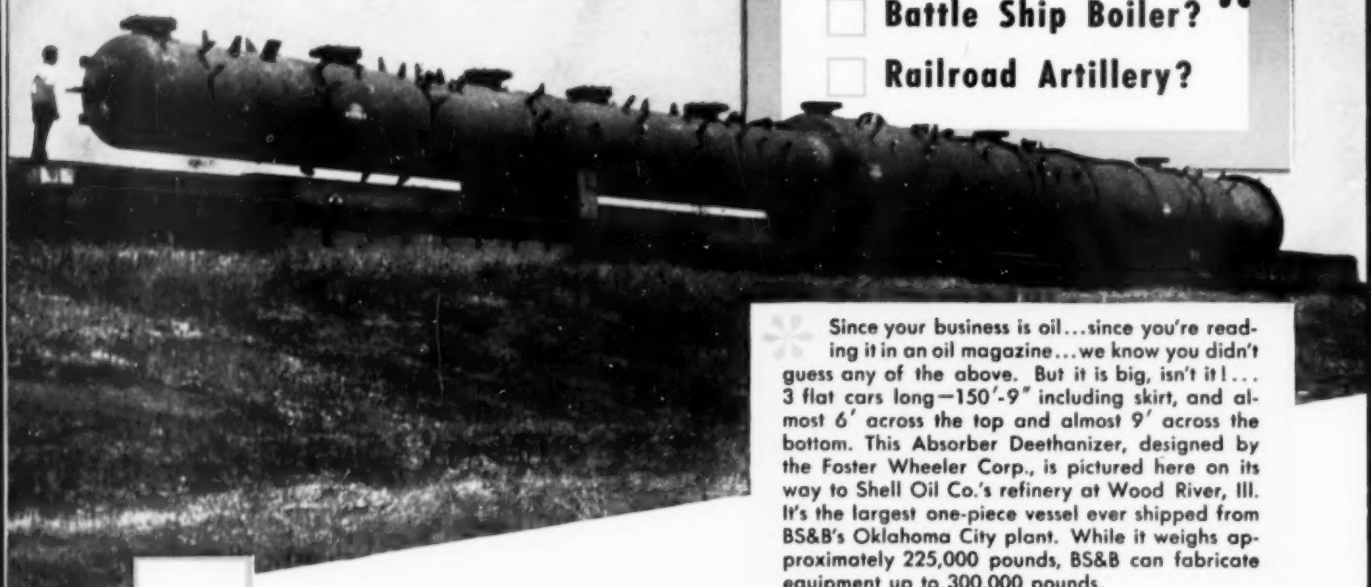
Another ROCKWELL Product



Gear operated semi-steel Nordstrom valve on dry hydrogen supply line on ammonia unit.

What's your guess?

- ☐ Super Telescope?
- ☐ Giant Smokestack?
- ☐ Battle Ship Boiler?
- ☐ Railroad Artillery?



Since your business is oil...since you're reading it in an oil magazine...we know you didn't guess any of the above. But it is big, isn't it!... 3 flat cars long—150′-9″ including skirt, and almost 6′ across the top and almost 9′ across the bottom. This Absorber Deethanizer, designed by the Foster Wheeler Corp., is pictured here on its way to Shell Oil Co.'s refinery at Wood River, Ill. It's the largest one-piece vessel ever shipped from BS&B's Oklahoma City plant. While it weighs approximately 225,000 pounds, BS&B can fabricate equipment up to 300,000 pounds.

Block long example of why

BS&B is master of *Contract Fabrication*

Pictured here is a very good example of why BS&B is classed by the Petroleum Industry as masters of Contract Fabrication. To handle a job like this one takes extensive shop and equipment facilities...but it takes something equally important—experience, knowledge . . . "the feel, the flair, and the fist" for the needs of the Petroleum Industry.

Our 3,000 ton, triple-action hydraulic steel punch press is one of the midwest's largest. Our new 2000° F. stress relieving furnace is 15′-8″ wide, 80′ long and 15′-8″ high above car. We use submerged arc (automatic), metallic arc (manual), oxyacetylene, and inert-gas-shielded metal arc welding. We can handle diameters from 16″ through 13′-0″ . . . plate thicknesses from 14 gauge through 5″. In our well equipped machine shop we can fabricate both ferrous and nonferrous alloys, solid and clad materials. The very latest quality control, inspection and testing equipment is in constant use.

Why not let BS&B's experienced and qualified engineers have a look at your project. Write . . .

Contract Sales Division, Dept. 5-D1

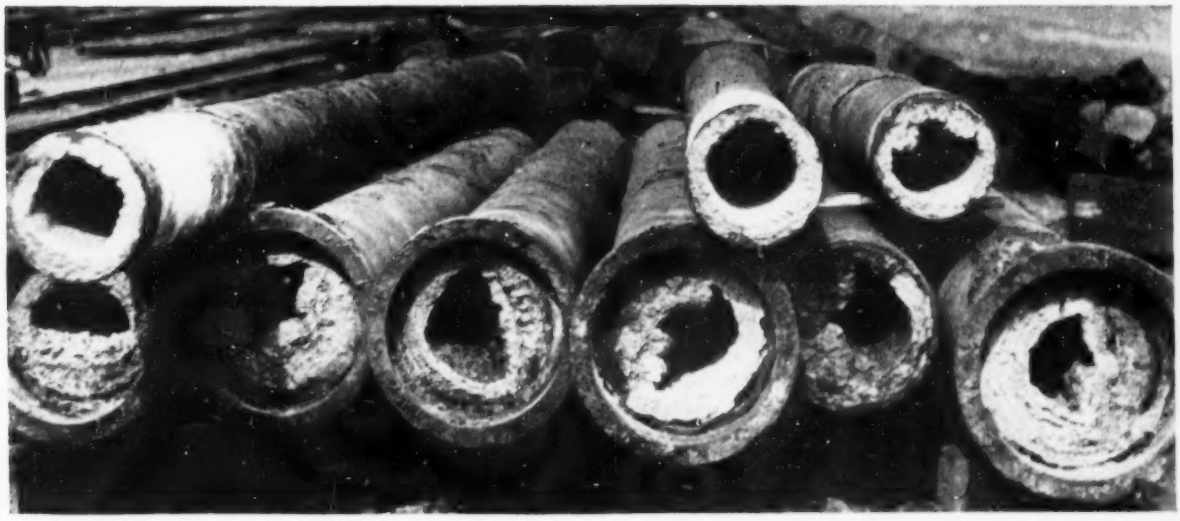
EFFICIENCY BS&B RELIABILITY
OUR 60TH YEAR

BLACK, SIVALLS & BRYSON, INC.

2131 Westwood Blvd. Oklahoma City, Oklahoma

ARE CLOGGED LINES LIKE THESE CUTTING YOUR WATER SUPPLY?

Over 1½ Miles of Buried Water Line Chemically Cleaned IN PLACE by Dowell Service



You don't have to dig up water lines in order to clean them! Take the case of a major railroad that had over 8600 feet of *buried* water lines, ranging from 2 to 12 inches in diameter. The capacity of these lines had been greatly reduced by scale deposits. Dowell Service used liquid solvents to clean all the lines, *in place*, during a period of only six days with a minimum interruption in service.

Dowell Service offers *fast*, effective chemical cleaning of pipelines of all kinds—water lines, disposal lines and product lines. And, whether these lines are underground or above, indoors or out, no digging or dismantling is necessary. Dowell solvents are designed to dissolve the accumulated deposits, and are introduced through regular connections. Because they are liquid, Dowell solvents reach wherever steam or water can flow, cleaning places inaccessible by other methods—angles, curves, valves, complicated surfaces and hook-ups. *Experienced* Dowell engineers do the job using Dowell-designed truck-mounted pumps, mixers and control equipment.

Many other types of equipment can also be cleaned chemically by Dowell. If you have boilers, condensers, evaporators, bubble towers, water wells or other operating equipment where deposits are reducing capacity, let Dowell Service *save you time and money in maintenance cleaning!*

FIND OUT ABOUT CHEMICAL CLEANING! There are many places in your plant where Dowell Service can clean equipment faster and better than out-dated mechanical methods. Call your nearest Dowell office for a fact-filled book. Or write direct to Tulsa, Dept. A32.

DOWELL SERVICE

Over 100 Offices to Serve You with Chemical Cleaning for:

Boilers • Condensers • Heat Exchangers • Cooling Systems
Pipe Lines • Piping Systems • Gas Washers • Process Towers
Process Equipment • Evaporators • Filter Beds • Tanks

Chemical Services for Oil, Gas and Water Wells

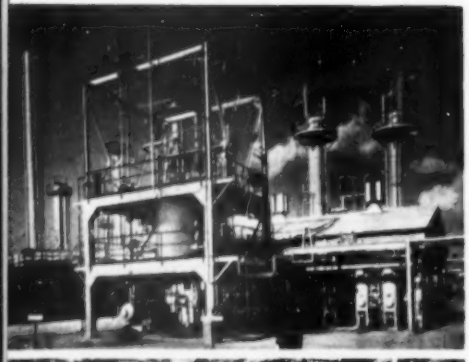
DOWELL INCORPORATED
Tulsa 1, Oklahoma

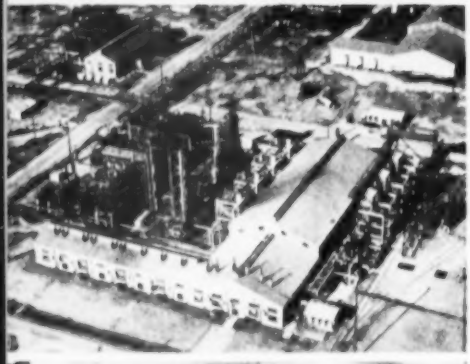
Look to **DOWELL**

FOR OIL INDUSTRY CHEMICAL SERVICE

 (To obtain more data on advertised products see page 128)

HERE ARE 5 REASONS WHY YOU SHOULD TALK TO M. W. KELLOGG ABOUT Petrochemicals Processing...





1 NEW PROCESSES AVAILABLE . . .

Using new processing techniques, Kellogg is now in a position to design plants for the production of a wide variety of valuable chemicals from hydrocarbon feeds. As a result of recently completed arrangements these include, for example, urea via Montecatini's vastly improved process. Others are ammonia, phenol and acetone, aromatics, higher aliphatic and cyclic alcohols, and phthalic anhydride.

2 CURRENT PRACTICAL DESIGN EXPERIENCE . . .

Today, with nearly a score of different chemical plants either under construction or in engineering, Kellogg is able to offer broad chemical experience—all based on the practical chemical engineering philosophy of continuous processing in integrated plants.

3 EXTENSIVE LABORATORY FACILITIES . . .

Kellogg pilot plant and organic laboratory facilities are among the most extensive in the industry. The firm is well known among the process industries for its ability to cooperate closely in the development of new proc-

esses—and for its engineering know-how in the translation of pilot plant and semi-commercial plant data into profitable commercial operations.

4 **PETROCHEMICAL BACKGROUND . . .**

Since World War II when Kellogg engineered butadiene and ammonia plants . . . and later, special units for the production of ethylene, hexylene glycol and ethyl chloride as well as highly efficient fractionation systems for the concentration of butylene . . . the company has continued its research and development work in this expanding field.

5 **BASIC ENGINEERING DATA . . .**

Behind the relatively new developments in chemical processing, Kellogg has a vast reservoir of technical data built up over years of designing, engineering and erecting petroleum refineries all over the world. Much of this experience is directly applicable to chemical process design.

• • •

If you have a refinery by-product that you wish to upgrade in value to petrochemical intermediate or final product, consider Kellogg's *practical* experience. Write—

Chemical Process Division

THE

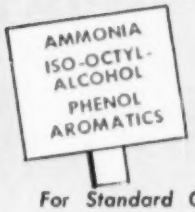
M. W. KELLOGG COMPANY

KELLOGG — PULLMAN

for fifty one years an integral part of processing history!

NEW YORK • JERSEY CITY • LOS ANGELES • TULSA • HOUSTON • TORONTO • LONDON • PARIS

These current projects demonstrate Kellogg's versatility in the chemical field...



In the United States

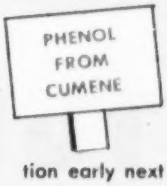
For Shell — An anhydrous ammonia plant for the West Coast.

For Standard Oil Co. (Indiana) — An iso-octyl-alcohol plant now under construction in the midwest.

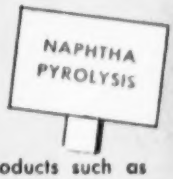
For Pan-Am Southern — The first Fluid Hydroformer. Although scheduled to upgrade naphthas to high grade motor gasoline, the unit can alternatively produce aromatics such as benzene, toluene and xylene.

For Cities Service — Two more Fluid Hydroformers, one for the Midwest and the other for the Gulf Coast.

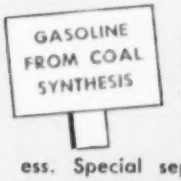
In Italy for Montecatini—Seven important units for the production of ethylene, propylene, and butylene as well as final products such as isopropanol, secondary butanol and phthalic anhydride.



In Canada for B-A Shawinigan — The World's first phenol-from-cumene plant. Scheduled for completion early next year, it promises to provide high quality phenol at low cost.



In England for ICI—Just completed, a naphtha pyrolysis plant producing better than 99.8% pure ethylene as well as useful by-products such as propylene and butylene. Also for ICI, a phthalic anhydride unit, now in engineering.



In South Africa for SASOL—A large gasoline-from-coal synthesis plant employing Kellogg's Synthol process. Special separation equipment to recover valuable alcohols and other oxygenated chemicals is part of the program.

Thirtieth Anniversary

TULSA

MAY 14-23
1953

EXPLORATION
DRILLING
PRODUCTION
PIPE LINE
REFINING
SCIENTIFIC

OVER 1,250
HIGH GRADE HOMES

are available for rental during the Oil Show to supplement hotel rooms. If you have a local representative, have him contact IPE or write direct to IPE Housing Bureau, 616 South Boston, while choice homes are still available.

Hooker Chemical Guide
(ONE OF A SERIES)
USE this handy reference to save time in selecting high-quality chemicals.

HOOKER SOLVENTS

MONOCHLOROBENZENE

Synonym: Phenyl Chloride
Formula: C_6H_5Cl
Molecular Weight: 112.5
Appearance: Clear, colorless liquid

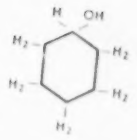
TYPICAL PROPERTIES

Freezing Point	−44° C
Distillation Range	131.2° to 132.2° C
Specific Gravity, 15.5°/15.5° C	1.114

USES

INSECTICIDAL INTERMEDIATE: DDT and other insecticides.
DYESTUFF INTERMEDIATE: Sulfur black and brown dyes.
CHEMICAL INTERMEDIATE: Organic synthesis.
SOLVENT: Paints, varnishes, lacquers, paint removers; general use.
HEAT TRANSFER FLUID: Suggested for condensing vapor systems, such as glass-enameled vessel jackets, which cannot stand high steam pressures.

CYCLOHEXANOL



Synonym: Hexahydrophenol
Formula: $C_6H_{11}OH$
Molecular Weight: 100.1
Appearance: Viscous, colorless liquid with pleasant, aromatic odor.

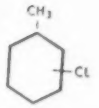
TYPICAL PROPERTIES

	High Grade	Tech. Grade
Freezing Range	18° to 22° C	−10° C to −20° C
Boiling Point	161.7° C	161.7° C
Specific Gravity, 25°/15.5° C	0.945	0.939
Flash Point	67° C	61° C

USES

SOLVENT: For resins, metallic soaps, dyes, fats and oils.
BLENDING AND STABILIZING AGENT: In textile soaps and dry cleaning agents.
HOMOGENIZING AGENT: For lacquers, varnishes and paints.
ALSO USED: In furniture and metal polishes, shoe creams, floor waxes, degreasing of leather, lubricating oils, also a plasticizer and ingredient of adhesives, and as a chemical intermediate in organic synthesis.

MONOCHLOROTOLUENE



Synonym: Methylchlorobenzene
Formula: $CH_3C_6H_4Cl$
Molecular Weight: 126.5
Appearance: Clear, colorless to straw-colored liquid.

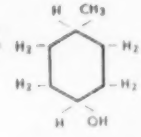
TYPICAL PROPERTIES

Freezing Point	below −45° C
Distillation Range	158.3° to 161.7° C
Specific Gravity, 15.5°/15.5° C	1.080

USES

SOLVENT: Rubber and synthetic resins.
INTERMEDIATE: Manufacture of rubber accelerators, chemicals.

METHYL CYCLOHEXANOL



Synonym: Hexahydrocresol
Formula: $CH_3C_6H_{11}OH$
Molecular Weight: 114.1
Appearance: Light straw-colored, neutral, viscous liquid.

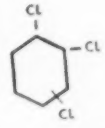
TYPICAL PROPERTIES

Distillation Range	155° to 180° C
Specific Gravity, 15.5°/15.5° C	0.924
Flash and Fire Points	71° C

USES

SOLVENT: For cellulose acetate, nitrocellulose and other cellulose esters for lacquers and coating compositions.
ANTI-OXIDANT: In lubricants.
BLENDING AGENT: For special textile soaps and detergents.

TRICHLOROBENZENE, Tech.



Formula: $C_6H_3Cl_3$
Molecular Weight: 181.5
Appearance: Clear, almost colorless liquid

TYPICAL PROPERTIES

Freezing Point	10° C
Distillation Range	5° incl. 216° C
Specific Gravity, 15.5°/15.5° C	1.466

USES

INSECTICIDE: Soil poison for termites.
SOLVENT: Fats, oils, waxes, resins; crystallization solvent.
HEAT TRANSFER MEDIUM: Condensing vapor systems, 210° to 300° C.
DIELECTRIC FLUID: Transformers.
INTERMEDIATE: Dye intermediates, other organic chemicals.

• *For more information on items listed,* drop a note on your letterhead to:

HOOKER ELECTROCHEMICAL COMPANY
4713 Buffalo Avenue, Niagara Falls, N. Y.

HOOKER ELECTROCHEMICAL COMPANY

NIAGARA FALLS, N. Y. • NEW YORK, N. Y.
TACOMA, WASH. • CHICAGO, ILL. • LOS ANGELES, CALIF.

From the Salt of the Earth

HOOKER® CHEMICALS

2-1520

Is pressure drop your problem ?

As simple as 2 plus 2—when you can recover 85% to 92% of the slot energy as mixing energy, you'll find your pressure drop problems are solved . . . and only Benturi Kaskade trays will give you this amount of recovery when and where you want it.

KOCH ENGINEERING COMPANY, INC.

DESIGNERS · MANUFACTURERS · BUILDERS

321 WEST DOUGLAS — WICHITA 2, KANSAS

REPRESENTATIVES

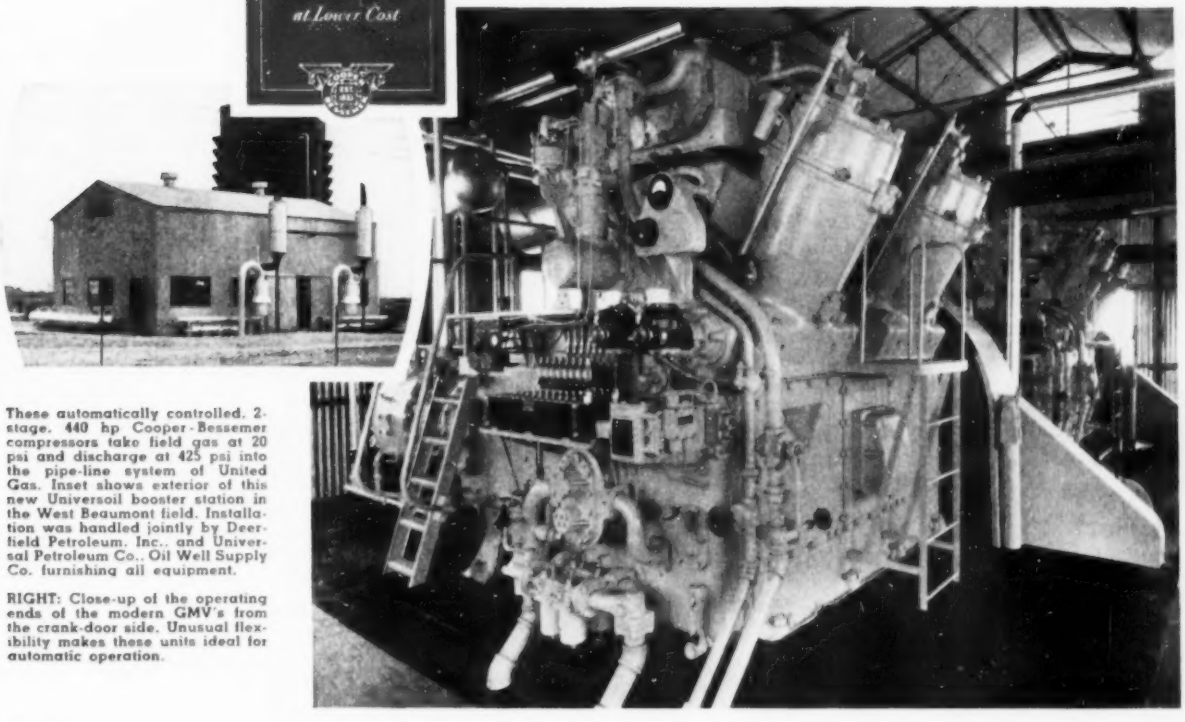
Eastern and Export
30 Rockefeller Plaza
New York City

Pittsburgh, Pa., Repr.
D. D. Foster Co.
714 Frick Bldg.

Tulsa, Okla., Repr.
Myers-Bagwell Co.
Wright Bldg.

British Associates
Messrs A. McCraig & Co., Ltd.
Paisley, Scotland

Another Example of Efficient Power at Lower Cost



These automatically controlled, 2-stage, 440 hp Cooper-Bessemer compressors take field gas at 20 psi and discharge at 425 psi into the pipe-line system of United Gas. Inset shows exterior of this new Universoil booster station in the West Beaumont field. Installation was handled jointly by Deerfield Petroleum, Inc., and Universal Petroleum Co., Oil Well Supply Co. furnishing all equipment.

RIGHT: Close-up of the operating ends of the modern GMV's from the crank-door side. Unusual flexibility makes these units ideal for automatic operation.

More profit in gas conservation...

...WITH GMV ONE-MAN AUTOMATIC OPERATION

WHEN a booster station practically runs itself, month in, month out, gas conservation is bound to be more practical, more profitable! And that's the success story behind those Cooper-Bessemer GMV V-Angles, shown opposite, in Universoil's new station in the West Beaumont field.

These two GMV's are daily handling 4,800,000 feet of gas that ordinarily would be flared—doing it efficiently *with the attention of one man for each 24 hours of operation!* It's a good example of the adaptability of modern Cooper-Bessemer V-Angles to extensive automatic control. The installation features variable speed governors to meet wide load variations, as well as automatic shutdown devices on the cooling water and lube oil systems. Likewise, the inlet scrubbers have low-liquid-level dump and shutdown controls.

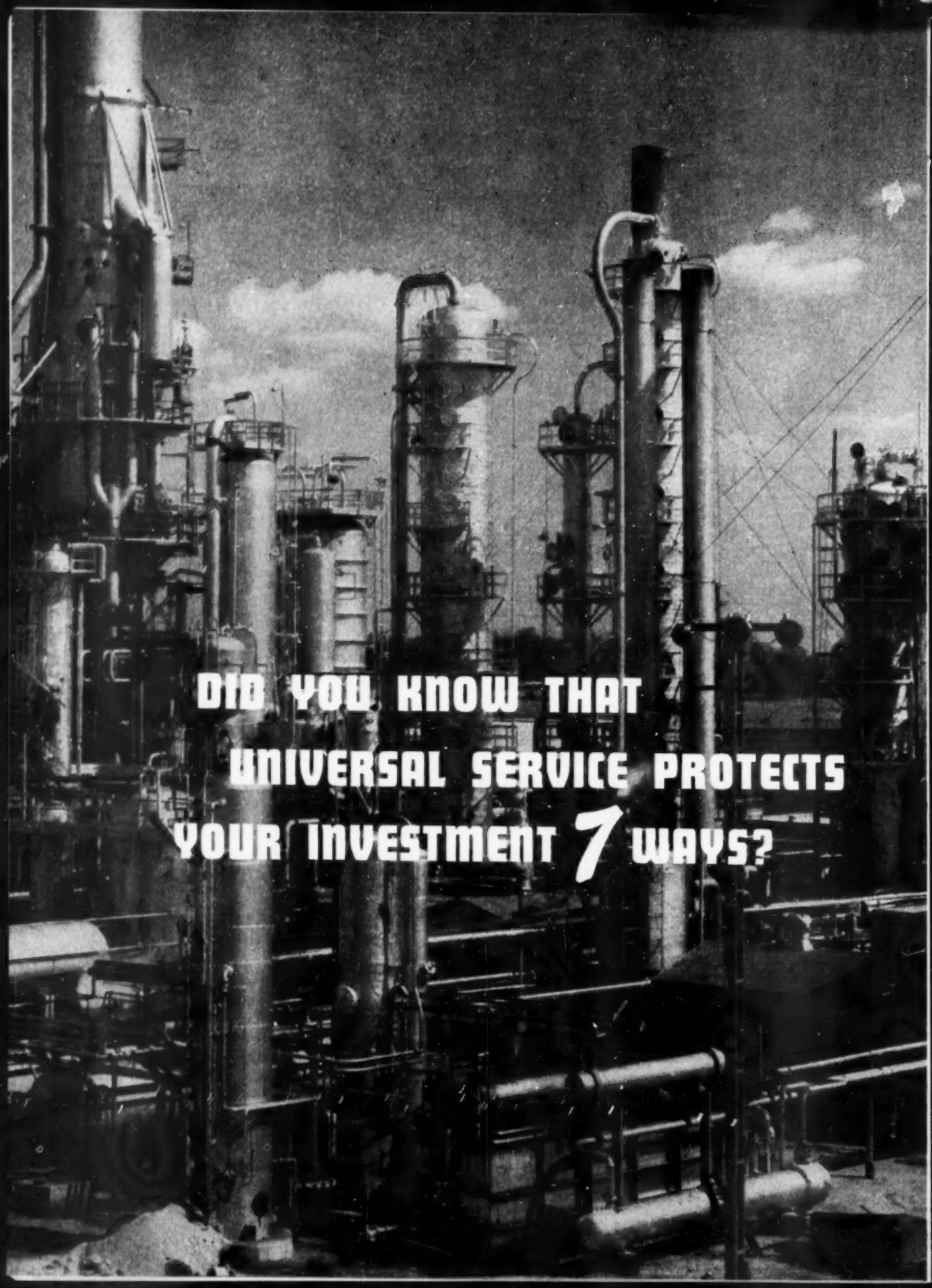
If you're planning compressor jobs from 220 to 3,000 hp, automatically controlled or otherwise, check on Cooper-Bessemer V-Angles—today's and tomorrow's answer to compressor performance at its best.

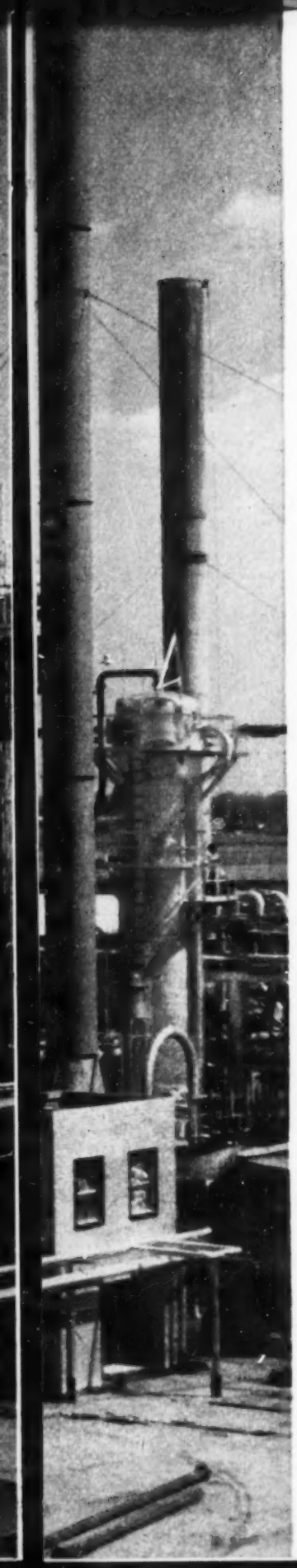
The **Cooper-Bessemer** *Corporation*

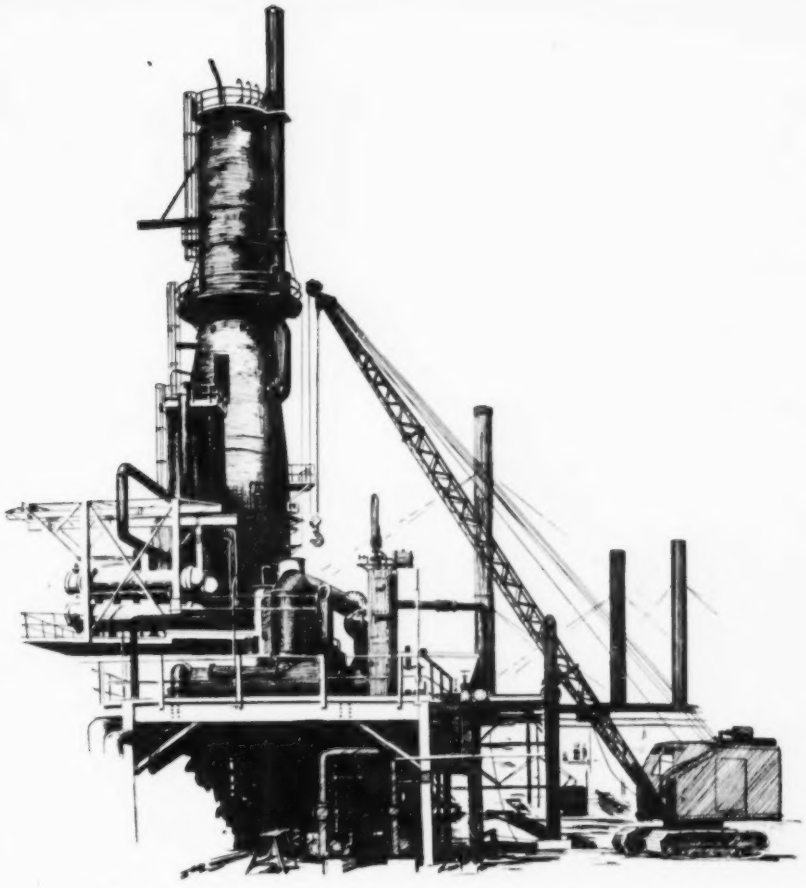
MOUNT VERNON, OHIO — GROVE CITY, PENNA.

New York, N. Y. Washington, D. C. Bradford, Penna. Parkersburg, W. Va.
San Francisco, Calif. Houston, Dallas, Greggton, Pampa and
Odessa, Texas Seattle, Wash. Tulsa, Okla. Shreveport, La.
St. Louis, Mo. Los Angeles, Calif. Chicago, Illinois Caracas, Venezuela

(*To obtain more data on advertised products see page* 128)


DID YOU KNOW THAT
UNIVERSAL SERVICE PROTECTS
YOUR INVESTMENT 7 WAYS?





UOP CONSTRUCTION SUPERVISION PROTECTS YOUR INVESTMENT

The participation of Universal supervisory engineers in the construction of petroleum processing facilities adds an authoritative measure of confidence to the refiner's improvement or expansion plans.

Petroleum executives and contruction engineers recognize the wealth of practical experience gained by UOP engineers through their direction of a broad range of process construction projects throughout the world. And their concentration in the petroleum refining field has afforded them a specialized knowledge of the design, construction and operation of all types and sizes of processing units.

Universal construction supervision is a valuable asset to both the refiner and his contractor in assuring the scheduled completion of the project and its efficient on-stream operation — another important way in which Universal Service Protects Your Investment.

UNIVERSAL OIL PRODUCTS COMPANY

General Offices: 30 ALGONQUIN ROAD, DES PLAINES, ILL., U.S.A.
Laboratories: RIVERSIDE, ILLINOIS

Universal Service Protects Your Investment through laboratory research . . . pilot plant studies . . . design and engineering . . . construction supervision . . . licensee instruction . . . post on-stream service . . . collateral services.

TO

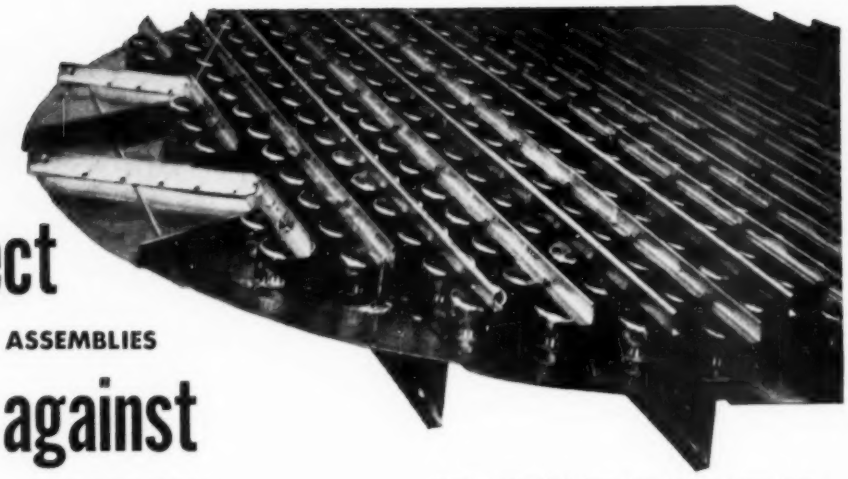
protect

YOUR CAP AND TRAY ASSEMBLIES

against

CORROSION

damage



Fritz W. Glitsch & Sons, Inc., Dallas, Texas, fabricated this lightweight bubble cap and tray assembly of corrosion-resisting Monel to withstand hydrochloric acid corrosion in the top section of a refinery fractionating tower. The strength and ductility of wrought Monel and Inconel lessen chances of breakage during installation. Trays which have been distorted by explosion can readily be straightened in the field.

There are two commercial non-ferrous metals that offer the protection your fractionating and distillation equipment needs.

Each gives you excellent corrosion resistance...*plus* high strength ...*plus* toughness...*plus* ductility.

Both metals are Inco nickel alloys – Monel and Inconel.

Their properties make it possible to use relatively thin-gauge metal for many applications. This means, of course, that you get lighter assemblies. Your cost for materials is lower...and installation and maintenance easier.

What governs your choice of Monel or Inconel? For the most part, it depends on service conditions.

Monel caps and trays are usually preferred where operating temperatures remain below 500°F. They are used to withstand the effects of dilute hydrochloric acid and wet sulfur types of corrosion in the upper sections of fractionating towers...and in the regeneration of spent caustic soda. Inconel, the nickel-chromium alloy, is used to resist high-temperature oxidation attack and naphthenic acids.

A wide range of designs is possible with Monel and Inconel. All are readily fabricated. They can be cut, formed, machined and welded by ordinary shop methods. They need no heat treatment after fabrication to develop maximum resistance to corrosion.

Keep Monel and Inconel in mind when you run into problems involving the use of metals in fractionation. And call on Inco's Technical Service for all the help you need. They have a world of information on hand, and are always glad to share it with you. The International Nickel Company, Inc., 67 Wall Street, New York 5, N. Y.

Successful Experiment. Here you see the excellent condition of a Monel cap and tray assembly after extensive experimental service at the top of a caustic soda regenerator unit. Note how badly the adjacent steel wall has been corroded. In the same column, a steel tray with cast iron bubble caps ➧ was located directly beneath the all-Monel top assembly. Corrosion made visible progress on the lower assembly, while the top tray and caps easily withstood attack.

Because of defense needs, Inco Nickel Alloys are now on extended delivery. Orders should be placed well in advance, together with NPA rating and complete end-use information.

Inco Nickel
ALLOYS

Monel® • "R"® Monel • "K"® Monel
"KR"® Monel • "S"® Monel • Nickel
Low Carbon Nickel • Duranickel® • Inconel®
Inconel "X"® • Incoloy • Nimonics®

(*To obtain more data on advertised products see page* 128)

these steam traps won't freeze up!

Freeze-ups of outdoor steam traps in winter weather often cause production delays. Don't take that chance . . . especially when it's so easy to install Yarways, the steam traps that *won't freeze up.*

They won't freeze because condensate does not accumulate. The only moving part—a little valve—is continually testing for condensate, discharging it as soon as it forms. There's never anything to freeze.

Other reasons why over 850,000 Yarway Impulse Steam Traps have been sold—they get equipment hotter, sooner; light weight; small size; easy to install and maintain; good for all pressures; made of stainless steel.

More than 200 industrial distributors sell Yarway Traps and Strainers. See your nearest one today. For name, and free 24-page Steam Trap Book, write . . .

YARNALL-WARING COMPANY
153 Mermaid Lane, Philadelphia 18, Pa.

YARWAY

the steam trap designed with more production in mind

(To obtain more data on advertised products see page 128)

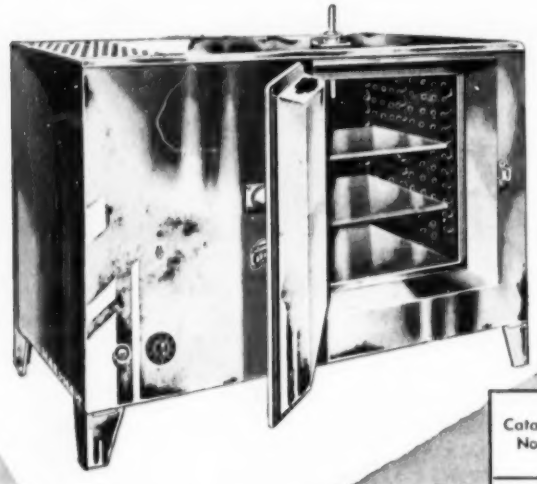
Whether you need an oven for annealing, evaporating, heat treating, or sterilizing or a vacuum oven for dehydrating, the oven you get must be capable of maintaining the temperature required.

"Precision" freas ovens

Years of accurate, efficient, trouble-free service have proven the superiority of the Precision Freas ovens. These ovens feature a hydraulic thermostat that is simple, rugged and extremely accurate. It is totally enclosed and the contact points require absolutely no attention. The heating element is designed with a high voltage safety factor and with ribbon elements that resist corrosion and oxidation.

Both the thermostat and the heater element are covered by a five year written guarantee.

Your local Harshaw Scientific representative will be glad to help you select the oven that will best fit your lab requirements.



Immediately Available!

Catalog No.*	Mod.	Max. Temp. °C	Watts	Cabinet wide deep high	Overall wide deep high	Price Iron Ext.	Price SS Ext.
H-52800	100	180	600	13 x 14 x 13	25 x 22 x 28	$195	$235
H-52800	104	260	1200			220	260
H-52800	120	180	1200	25 x 19 x 19	37 x 27 x 34	348	420
H-52800	124	260	2400				460
H-52900	601	180	1400	13 x 14 x 13	39 x 22 x 26	485	
H-52900	605	260	2600				600
H-52900	621	180	2700	19 x 19 x 19	49 x 26 x 33		690
H-52900	641	180	4100	37 x 19 x 25	72 x 27 x 39	880	
H-52900	645	260	5300			965	
H-52910	821	180	2700	19 x 14 x 19	30 x 22 x 61	590	680
H-52910	825	260	3900			655	
H-52970	500	180	800	13 x 14 x 13	25 x 22 x 28	365	405

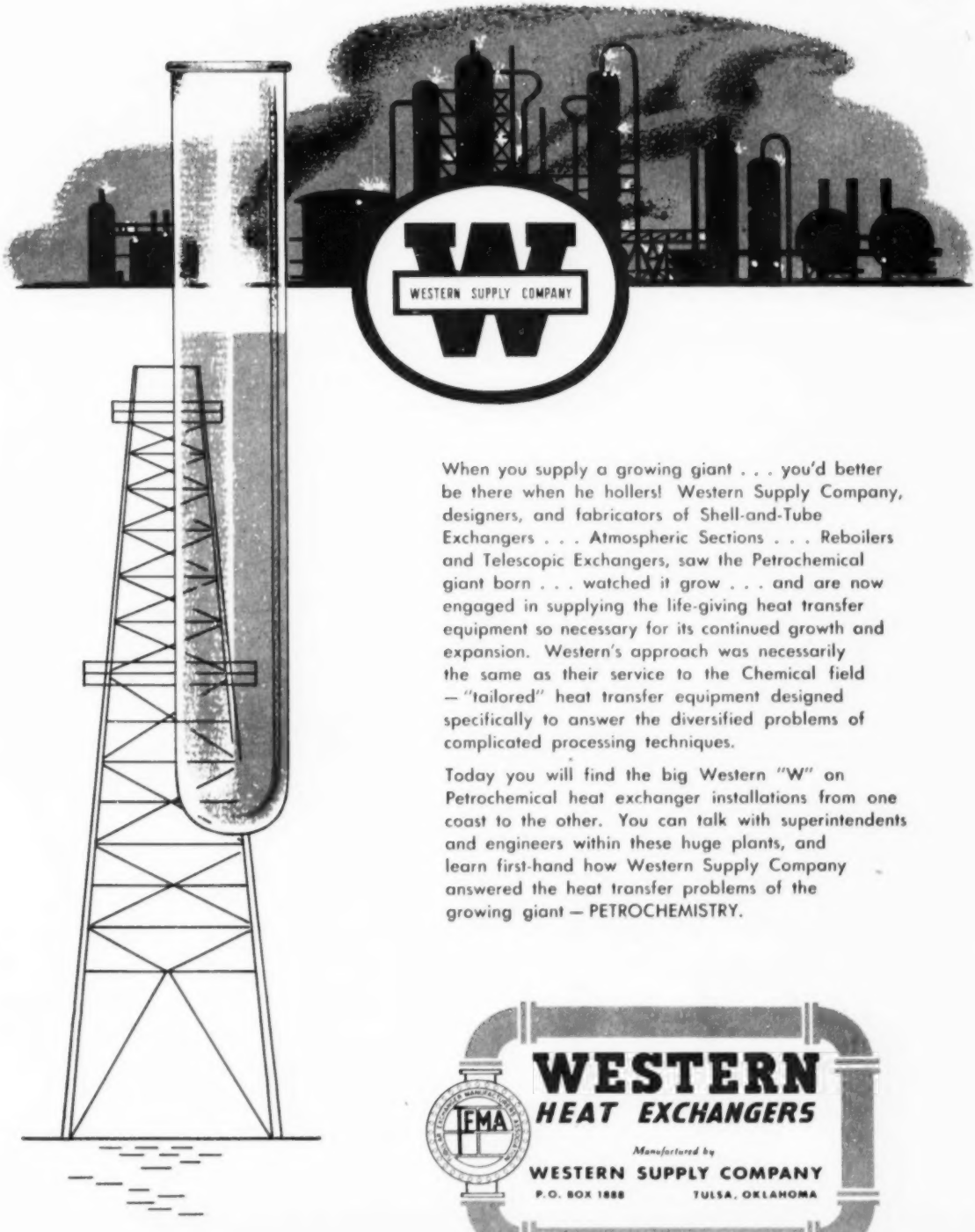
* Add A to Cat. No. for iron exterior; B for stainless steel.

HARSHAW SCIENTIFIC
DIVISION OF THE HARSHAW CHEMICAL CO.
CLEVELAND 6, OHIO

Cleveland 6, Ohio.....1945 East 97th St.
Cincinnati 2, Ohio.....224-226 Main St.
Detroit 28, Mich......9240 Hubbell Ave.
Houston 11, Texas.....6622 Supply Row
Los Angeles 22, Calif....3237 S. Garfield Ave.
Philadelphia 48, Pa.....Jackson & Swanson Sts.

(To obtain more data on advertised products see page 128)

HEAT TRANSFER for the *Petrochemical Industry*



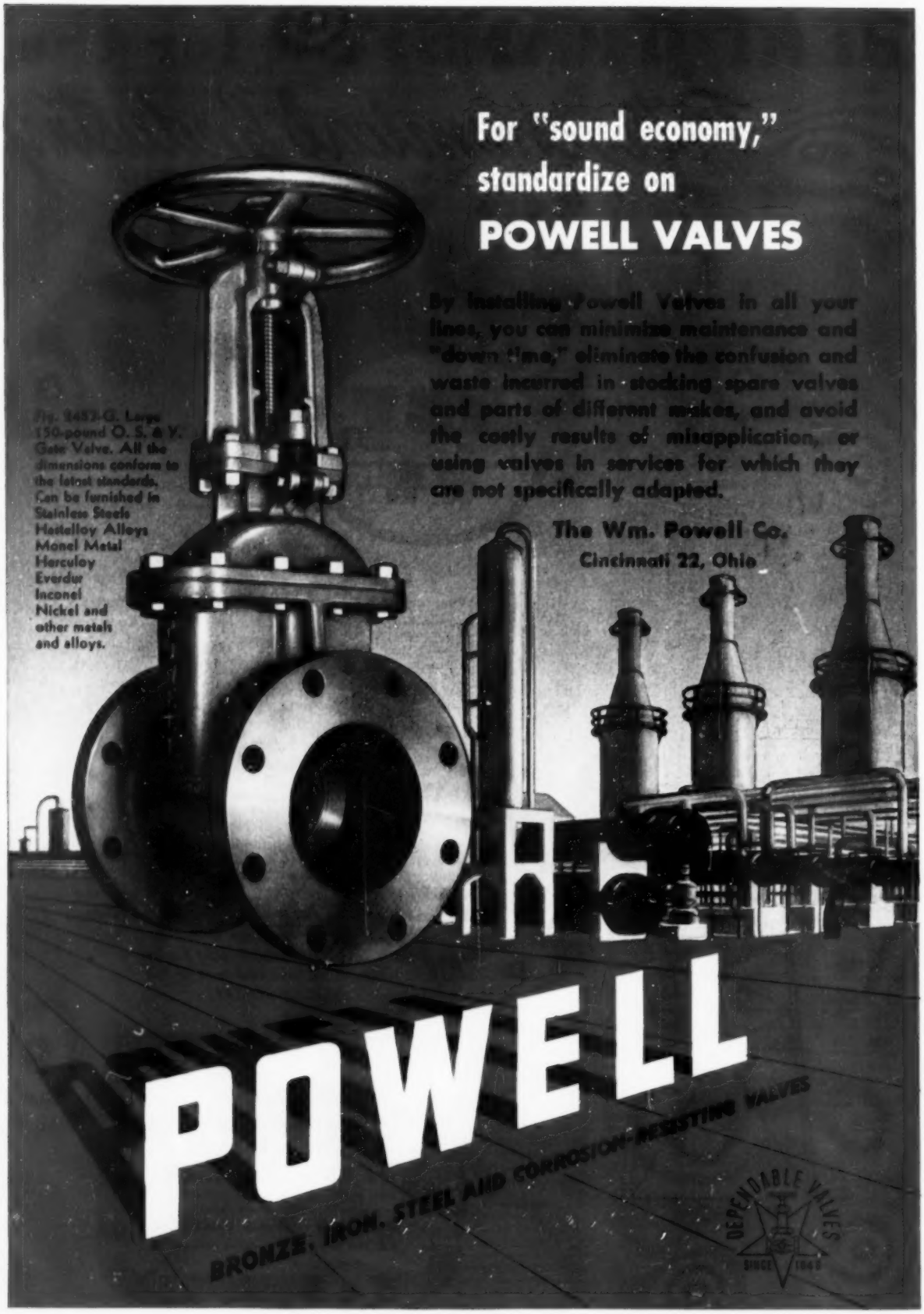
When you supply a growing giant . . . you'd better be there when he hollers! Western Supply Company, designers, and fabricators of Shell-and-Tube Exchangers . . . Atmospheric Sections . . . Reboilers and Telescopic Exchangers, saw the Petrochemical giant born . . . watched it grow . . . and are now engaged in supplying the life-giving heat transfer equipment so necessary for its continued growth and expansion. Western's approach was necessarily the same as their service to the Chemical field — "tailored" heat transfer equipment designed specifically to answer the diversified problems of complicated processing techniques.

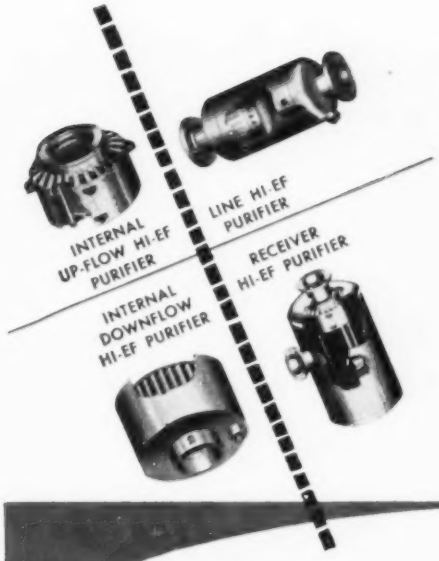
Today you will find the big Western "W" on Petrochemical heat exchanger installations from one coast to the other. You can talk with superintendents and engineers within these huge plants, and learn first-hand how Western Supply Company answered the heat transfer problems of the growing giant — PETROCHEMISTRY.

WESTERN
HEAT EXCHANGERS

Manufactured by
WESTERN SUPPLY COMPANY
P.O. BOX 1888 TULSA, OKLAHOMA

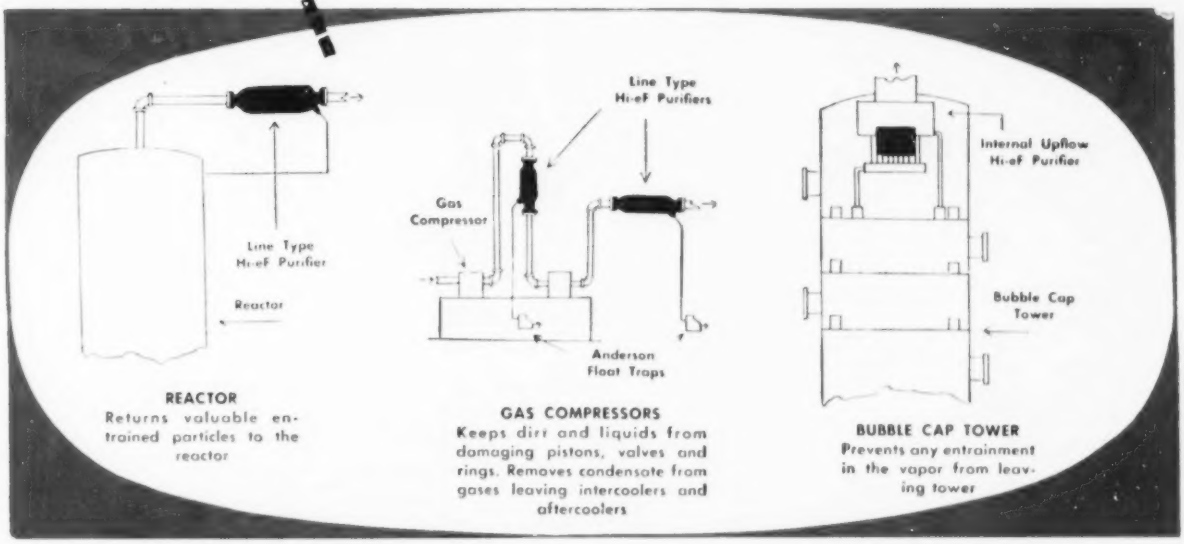
(To obtain more data on advertised products see page 128)


For "sound economy," standardize on
POWELL VALVES
By installing Powell Valves in all your lines, you can minimize maintenance and "down time," eliminate the confusion and waste incurred in stocking spare valves and parts of different makes, and avoid the costly results of misapplication, or using valves in services for which they are not specifically adapted.
The Wm. Powell Co.
Cincinnati 22, Ohio
Fig. 2452-G. Large 150-pound O. S. & Y. Gate Valve. All the dimensions conform to the latest standards. Can be furnished in Stainless Steels Hastelloy Alloys Monel Metal Herculoy Everdur Inconel Nickel and other metals and alloys.
POWELL
BRONZE, IRON, STEEL AND CORROSION-RESISTING VALVES
DEPENDABLE VALVES
SINCE 1846



Hi-eF PURIFIERS

SOLVE DOZENS OF DIRT, MOISTURE & ENTRAINMENT PROBLEMS IN REFINERIES



REACTOR
Returns valuable entrained particles to the reactor

GAS COMPRESSORS
Keeps dirt and liquids from damaging pistons, valves and rings. Removes condensate from gases leaving intercoolers and aftercoolers

BUBBLE CAP TOWER
Prevents any entrainment in the vapor from leaving tower

● Every petroleum engineer and production man knows that steam, vapors, compressed air and gases pick up entrained moisture and solids as they pass through pipelines. This entrainment may be in the form of line scale, rust and condensate that damage equipment . . . or valuable liquids arising with the vapor in bubble cap towers, vacuum towers, stripping columns, reactors and the like.

But whatever the case may be, the big problem is how to effectively intercept these entrained particles. At last there is a *new, easy, economical* way to remove dirt and moisture from all kinds of vapor and gas processes. Low-cost Anderson Hi-eF Purifiers embody a new design employing multi-stage separation guaranteed to remove or recover 99% of all entrainment! And it does the job without the use of filters, baffles or moving parts—and separation is accomplished with a minimum of pressure drop.

Save money for your plant. Use Hi-eF Purifiers to protect gas compressors . . . to knock down particles and recover valuable liquids in bubble cap towers, reactors and scores of other applications. Try one on your most troublesome entrainment problem. Anderson guarantees satisfactory results.

WATCHDOGS OF PIPELINE EQUIPMENT AND PROCESSES

THE V. D. ANDERSON COMPANY

1974 West 96th Street • Cleveland 2, Ohio

Please send me a copy of Bulletins describing your purifiers for the petroleum industry.

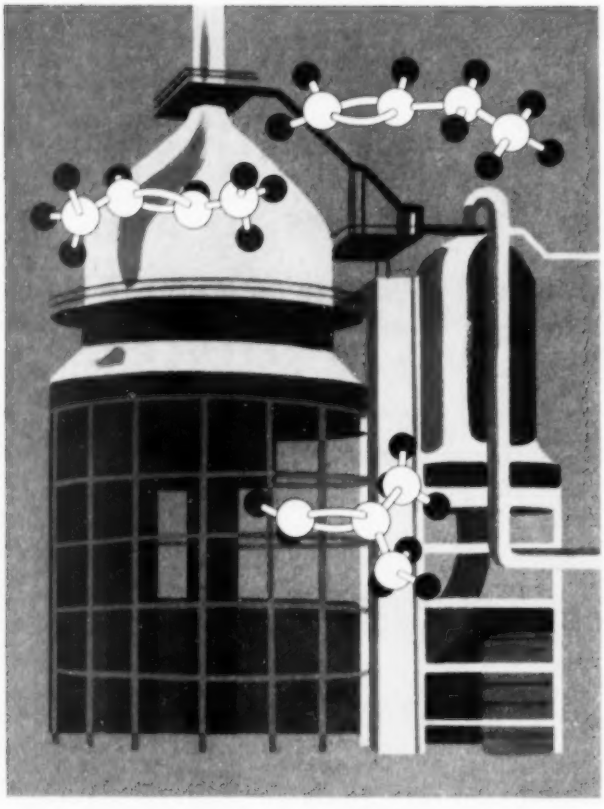
Name ..... Title .....

Address .....

City .....

State .....

BY THE MAKERS OF SUPER-SILVERTOP STEAM TRAPS



Meeting New Markets For Light Hydrocarbon Unsaturates

OTHER
REASONS FOR USING
FILTROL CATALYSTS

1. Higher Octane Barrels
2. Varied Plant Facilities
3. Low Cost
4. Sulphur Resistant Catalysts
5. Faster Regeneration Rate
6. Low Attrition
7. Technical Service
8. Uniformity
9. Lowered Excess Butane

FOR THE EVER-EXPANDING PETROCHEMICAL MARKET MAXIMUM YIELDS OF UNSATURATED HYDROCARBONS FROM CATALYTIC CRACKING OPERATIONS ARE NEEDED. FILTROL'S SR GRADES AND FILTROL'S REGULAR LINE OF FLUID AND PELLETED CATALYSTS OFFER OPPORTUNITIES FOR PRODUCING HIGHER YIELDS OF UNSATURATED C_3 AND C_4 HYDROCARBONS, WHILE MAINTAINING GASOLINE YIELD.

BOOKLET S-5 ON BUTYLENE YIELD PREDICTION AVAILABLE ON REQUEST.

Filtrol*

FILTROL CORPORATION

OFFICES: 727 WEST SEVENTH STREET, LOS ANGELES 17, CALIFORNIA
PLANTS: VERNON, CALIF.; SALT LAKE CITY, UTAH; JACKSON, MISS.

CATALYSTS AND ADSORBENTS

*T. M. REG. U. S. PAT. OFF.

DU PONT

PETROLEUM CHEMICALS DIVISION NEWS

DU PONT

January ★ One of a Series of Interest to the Petroleum Industry ★ 1953

When the Customer Says

The chances are it is caused by some factor other than gasoline quality.

To point up the seven common causes of knock – other than gasoline quality, Du Pont recently made up a folder on the subject.

Although originally designed to be handed out during dynamometer demonstrations, the folder proved to have such popular appeal that it has now been made available separately to oil company marketing groups for distribution to dealers.

For sample copies and information on how to obtain the folder, write the Wilmington office or any of the district offices of the Du Pont Petroleum Chemicals Division. Ask for the folder, "When the Customer Says 'Knock'."

Wildcat . . .

The Educational Game of Drilling Facts and Risks

About a year ago a game based on actual drilling statistics was developed and patented by the Du Pont Petroleum Chemicals Division. This game called "Wildcat," while entertaining, shows in a dramatic manner the high cost and the financial hazards of the search for oil.

The players act as individual operators. Starting with $900,000 they must lease properties, drill wells, produce and market oil—as well as pay the taxes on their profits. The odds in the game are based on national averages Taxes paid reflect actual rates and depletion allowance is included.

When first developed the cost of making the game was believed too great to allow wide distribution. Costs have now been reduced to the point where packaged, personalized games can be made for about one-sixth the original quoted price. This is cost of manufacture only. Necessary plates, dies, etc. are available without charge through the Petroleum Chemicals Division.

The first order for "Wildcat" has been placed and shipment received. Sample games are available to petroleum companies. Your Du Pont service representative can obtain a sample for you.

Suggested uses for the game are as an employee relations or public relations tool, or as part of a marketing program where a giveaway is desired.

The Service Station And The Motorist

National survey of consumer buying habits documents the Who . . . How . . . What . . . When and Where of service station purchases

A survey of buying habits at service stations has just been completed for the Du Pont Petroleum Chemicals Division. It was made as part of continuing market research studies. To date it is the largest single effort of this program. It is national in scope and contains five separate parts. The first is based on interviews in car-owning households. The other four are seasonal observations at service stations.

Pictured above is **E. HEARN SIMPSON,** Sales Manager of the Du Pont Petroleum Chemicals Division, at whose suggestion the survey was made. This picture points up the voluminous nature of the information collected to date.

The purpose of the survey was to document nationally and by four major marketing areas, the purchase patterns, attitudes and trends on the part of service station customers. It was designed to report accurately and impartially, information concerning the motorists' knowledge of gasoline brands and grades. Services asked for, given and expected were checked. Buying habits of oil and TBA items were probed.

All were analyzed and compared on the basis of four broad marketing areas, Northeast, South, Central and West, and by sex, income and age of the respondents. The service station observations were

OVER

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

PETROLEUM CHEMICALS DIVISION
NEWS

CONTINUED *Buying Survey*

catalogued by age and price of car. As such, we believe this survey to be the most comprehensive, penetrating and accurate ever undertaken by any segment of the petroleum industry.

PARTS TO BE PUBLISHED

From time to time, as information is collated and summarized, various portions of the survey will be printed by Du Pont and distributed to oil company marketing groups. The first of these reports is now being made ready for publication. It covers in brief form the selection of a service station and loyalty to the service station.

The reactions of dealers and station attendants, as well as motorists, were studied and are reported in the survey. To assure the utmost accuracy, the information was collected by two different methods – by interview and by observation.

SEASONAL BREAKDOWN

All of the interviews and observations were made by trained observers. More than 3,100 home interviews and approximately 24,000 observations of individual motorists at 1,193 service stations have been completed. The observations were spread over a year with about 6,000 being done in each of the four seasons – Spring, Summer, Fall and Winter.

The household study provides a base for measuring what people *say they do, why they do and think* certain things when buying gasolines. The station observation study shows what motorists *actually do* when buying gasoline. It also provides an insight into the kind of job the service station attendant does in selling gasoline, oil and TBA; and in providing customer services.

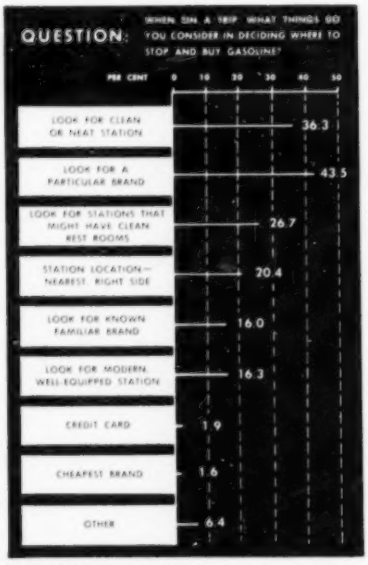
The 1,193 service stations and the 3,100 automobile-owning households were selected by the area sampling method. This is the same selective method that is used by the U. S. Bureau of the Census and by the Bureau of Internal Revenue as being the most accurate and representative. An indication of this accuracy is shown by the almost exact correlation between the makes of cars owned by families interviewed and the total car registration figures.

VOLUMINOUS STUDY

Six volumes totaling almost 800 pages make up the household interview reports. For ease of study these have been divided into six broad subjects:

1. Selection of the service station and station loyalty.
2. Brand name recognition and loyalty to brand.
3. Knowledge of gasoline grades and reasons for purchase.
4. Price, credit cards and charge accounts.
5. Oil and TBA purchases.
6. Services wanted by the motorist, asked for by the motorist, and given by the dealer.

Each of the four service station observations requires two volumes to report the findings. These add to and check the information obtained during the interviews.



TRAVELERS look for *brands* and *clean stations*. Regardless of the grade they buy, it's your brand that brings them in.

INFORMATION AVAILABLE

The full and complete information obtained by the survey is recorded on IBM cards and held for Du Pont by National Analysts, Inc., of Philadelphia, a subsidiary of Curtis Publishing Company. In this manner various cross checkings can be made as, for instance, services expected at west coast service stations by men between the ages of 35 and 50 years. Or, to provide an additional information breakdown such as urban vs. rural gasoline buying habits.

While this indicates the great scope of the survey, it also shows the difficulty volume-wise of assembling a complete survey for delivery to persons interested. However, material in the survey is available to the petroleum industry. Questions or requests for information should be addressed to any of the offices of the Du Pont Petroleum Chemicals Division.

LITERATURE AVAILABLE

Here is a partial listing of the bulletins, reports, booklets and aids available to you through your Du Pont Petroleum Chemicals Division district office:

Safety for the Small Refinery – A 42-page book on how to set up an effective small refinery safety program . . . . . Serial A-2848

Tank Talk – A 52-page, easy-to-understand safety booklet for tank-cleaning crews . . . . . Serial A-1134

Stability of Present-Day Gasolines – A 12-page paper on the value of storage tests—as compared with induction period—for determining stability of modern gasolines . Serial A-3199

MOVIES AVAILABLE

Pipeline on Wheels—A 26-minute, full-color movie on tank truck safety. Suitable for both training and public relations purposes.

What Makes A Gasoline Good—An 18-minute cartoon movie in color. Presents the story of how high quality gasoline is made in easy-to-understand form. Ideal for dealer training meetings.

In addition to the above, Du Pont makes available a special library of films of particular interest to the petroleum industry.

DU PONT
Better Things for Better Living
. . . through Chemistry

Petroleum Chemicals

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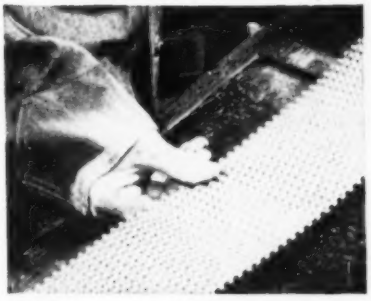
ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

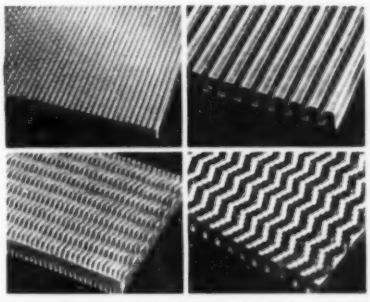
A-4687

Printed in U. S. A.

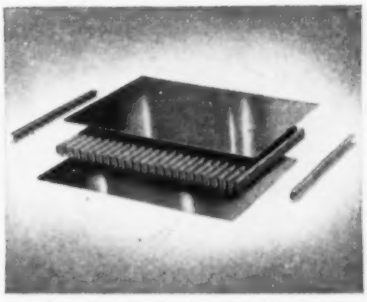
Here's how Trane brazes aluminum to solve tricky heat transfer problems...



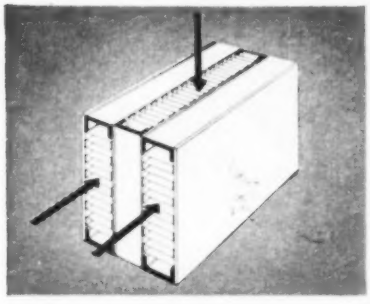
Corrugated fin surface for TRANE Brazed Aluminum Exchangers is formed in special presses from aluminum brazing sheet. Thickness can range from .005 to .032 inch; fin height to .50 inch; spacing 4 to 18 fins per inch.



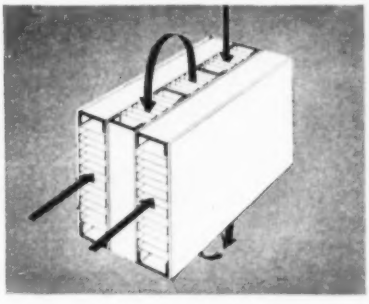
Many types of surface available. The brazed aluminum fins may be straight and continuous. Or they can be wavy, serrated or perforated to provide correct ratio of heat transfer to pressure drop.



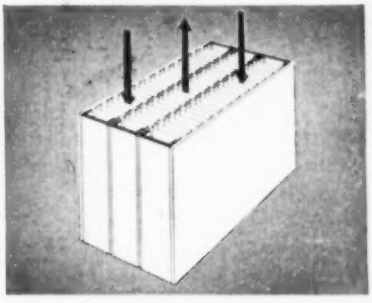
Exploded view shows component parts of a single passage. Fins, channels and parting sheets, all made from aluminum brazing sheet, become integrally bonded when assembled unit is submerged in a molten salt flux bath.



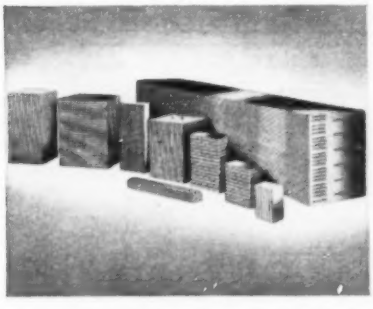
Cross-flow arrangement has fins in adjacent passages running crosswise to each other. TRANE Brazed Aluminum Surface can pack 450 square feet of heat transfer surface into one cubic foot of space.



Multi-pass arrangement, like the cross-flow type, has fins in adjacent passages running crosswise to each other. With this arrangement, however, alternate passages are constructed to produce multiple passes.



Counter-flow arrangement has fins in adjacent passages running parallel to each other. A wide variety of different types of corrugated fin sheets can be used to handle different fluids in the same exchanger.



A wide range of core sizes is available up to 106 inches in length. Either bolt-on or integrally welded headers can be provided. Individual cores can be welded together to form larger multi-core units.

Design flexibility permits construction of units to handle practically any specification of heat transfer, pressure drop, volume, number and direction of passes. Some units handle as many as six different fluids simultaneously!

TRANE

pioneers in the science of heat exchange

If you have a tricky problem in heat transfer . . . TRANE Brazed Aluminum Exchangers may be the answer. Contact your TRANE Sales Office or write direct.

The Trane Company, La Crosse, Wis. • East. Mfg. Div., Scranton, Penn. • Trane Co. of Canada, Ltd., Toronto. 80 U.S. and 14 Canadian Offices

New TRANSAIRE®

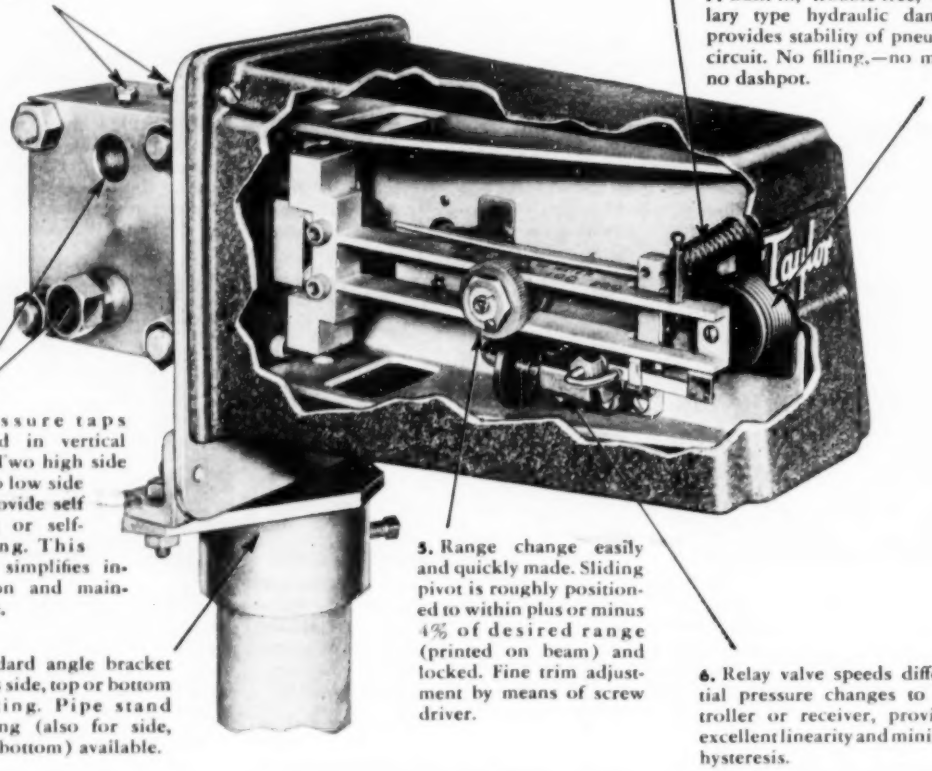
The new Taylor TRANSAIRE® Differential Pressure Transmitter

1. Dry meter operates on force-balance principle. Diaphragm of Teflon coated glass cloth. Body working pressure rating 1500 psi. Available in either forged steel or type 430 stainless steel.

2. Vent screws to provide for total filling in liquid service.

8. Provision for adjustment of range suppression up to 100%.

7. Built-in, trouble-free, capillary type hydraulic damping provides stability of pneumatic circuit. No filling,—no mess—no dashpot.

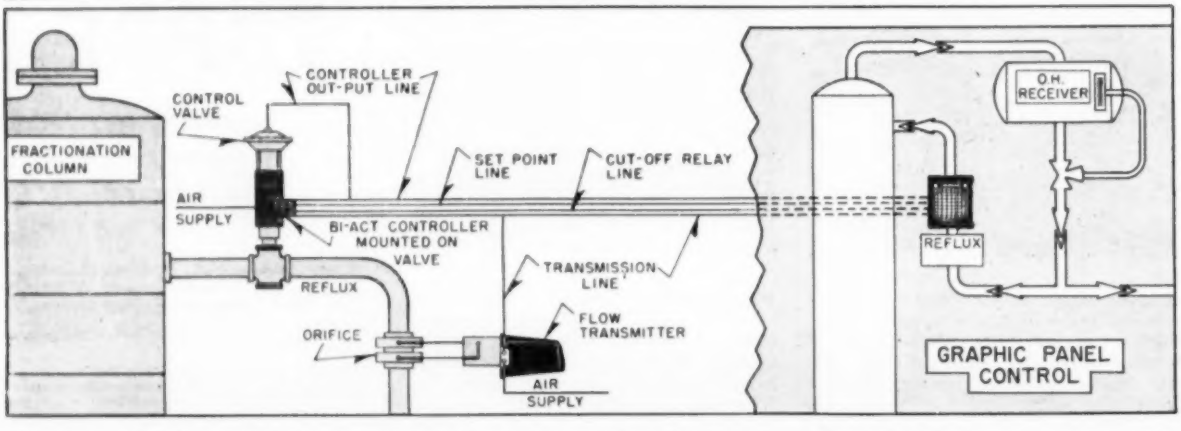


3. Pressure taps mounted in vertical plane. Two high side and two low side taps provide self venting or self-draining. This feature simplifies installation and maintenance.

4. Standard angle bracket permits side, top or bottom mounting. Pipe stand mounting (also for side, top or bottom) available.

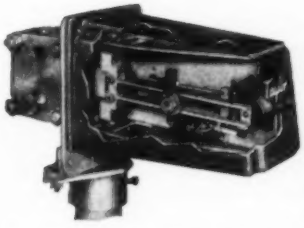
5. Range change easily and quickly made. Sliding pivot is roughly positioned to within plus or minus 4% of desired range (printed on beam) and locked. Fine trim adjustment by means of screw driver.

6. Relay valve speeds differential pressure changes to controller or receiver, providing excellent linearity and minimum hysteresis.



 (To obtain more data on advertised products see page 128)

Flow Transmitter widens selection of Taylor Transmitters!



THIS new Taylor Transmitter is the result of extensive field study and close collaboration with users of force-balance transmitters. It is designed to meet present day industrial requirements for a rugged, dependable and accurate instrument to measure flow, liquid level or specific gravity. With this new development three force-balance transmitters are now available for the measurement and transmission of flow, temperature and pressure.

INEXPENSIVE AND SIMPLE TO INSTALL

• Simplified piping because it can be close coupled to orifice flanges. • No seal pots required—negligible displacement because of force-balance construction. • No leveling—mercuryless dry meter. • Light weight for easy handling; weighs only 23 lbs.

ECONOMICAL, EASY TO MAINTAIN

• Self draining or venting—no periodic manual venting or draining. • Overrange protection to full body rating.

ACCURATE

• Relay valve for linearity, minimum hysteresis. fast speed of response. • Pressure effect 0.2% / 100 psi. change. • Temperature effect 1.0% / 100°F. change.

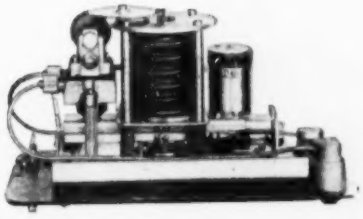
RUGGED AND DEPENDABLE

• Weatherproof housing built for tough service and outdoor mounting. • Force-balance construction; negligible motion; minimum possible wear. • Process sealing bellows 3 ply type 316 stainless steel.

▼ ▼ ▼

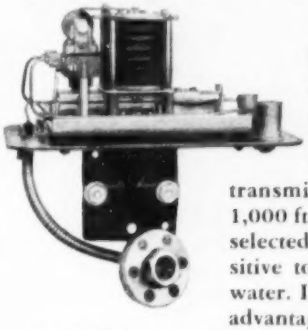
Ask your Taylor Field Engineer for full details of this new Taylor TRANSAIRE Differential Pressure Transmitter, or write for **Bulletin 98226.** Taylor Instrument Companies, Rochester, N.Y., and Toronto, Canada.

Instruments for indicating, recording and controlling temperature, pressure, flow, liquid level, speed, density, load and humidity.



TAYLOR TRANSAIRE TEMPERATURE TRANSMITTER

With Speed-Act. This is a compact, super-responsive instrument designed to measure and transmit smallest temperature changes up to 1000 ft. with great accuracy. It gives you: • Unprecedented speed of response provides dynamic accuracy thanks to derivative action (Speed-Act) in the *measuring* circuit. • It will transmit an output pressure proportional to the measured temperature with an accuracy of plus or minus 0.06 psi.



TAYLOR TRANSAIRE PRESSURE TRANSMITTER

A highly sensitive and accurate suppressed pressure measuring instrument, designed to measure and transmit pressure changes up to 1,000 ft. It is accurate to ½% of the selected short range span and sensitive to pressure changes of ½" water. It gives you these important advantages: • Short range spans available 20 to 40 psi. throughout range limits of 35 to 415 psia, and 50 to 100 psi. throughout 100 to 1,000 psia. • Volumetric type pressure system is extremely accurate, practically clog-proof, has corrosion resistant 316 stainless steel diaphragm. • Temperature and barometric compensation for higher accuracy of measurement and control.

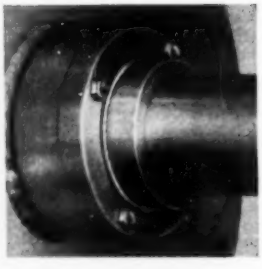
Taylor Instruments
MEAN
ACCURACY FIRST
IN HOME AND INDUSTRY

Easier to repack than ever before

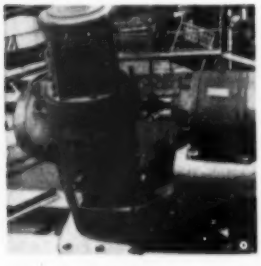
LIGHTNIN SERIES SE (gear drive). Sizes 1 to 25 HP. Also available in V-belt drive.

No wrenches needed to shut off stuffing box from tank contents

TO SHUT OFF WITH TANK FULL, operator loosens a set screw and turns handles on bronze housing. It's as easy as closing a valve.



INSIDE THE TANK, a Teflon gasket is compressed between the seal collar and end cap. This positively seals off tank contents.



TOP ENTERING turbine and paddle type mixers for open or closed tanks. Sizes 1 to 500 HP.

LIGHTNIN PORTABLE MIXERS ... Used everywhere for hundreds of fluid mixing jobs. Thirty models to choose from. Sizes ⅛ to 3 HP.

These two new LIGHTNIN Side Entering Mixers cut maintenance time in half, they're so easy to service.

When stuffing box needs to be repacked, your maintenance man just loosens one set screw. Then he easily shuts off the stuffing box from tank contents, by rotating the outboard bearing holder, which has two easy-to-get-at handles.

Returning the mixer to operating position is just as easy and foolproof. You've never seen anything so simple and slick in a side entering mixer.

This is just one of the features that will sell you on these new LIGHTNIN Mixers. Others are:

Your choice of stuffing boxes or mechanical seals to fit the mixing job.

Smoother operation because new vertical motor mounting (on gear drive units) moves center of gravity closer to tank, minimizing vibration.

Full guarantee says the mixer will do the job and do it *right*, or your money back.

Specify the new LIGHTNIN Mixers for gasoline blending, lube oil blending, sediment control—and wherever there's a *big* mixing job that must be done right. Call your MIXCO representative today, or write us for details.

"Lightnin® Mixers"

GET THESE HELPFUL LIGHTNIN CATALOGS

This library of mixing information is yours for the asking. Catalogs contain helpful data on impeller selection; sizing; best type of vessel; valuable installation and operating hints; complete description of LIGHTNIN Mixers.

MIXCO fluid mixing specialists

MIXING EQUIPMENT Co., Inc.

131 Mt. Read Blvd., Rochester 11, N. Y.

In Canada: William & J. G. Greey, Ltd., Toronto 1, Ont.

- ☐ DH-50 Laboratory Mixers
- ☐ B-75 Portable Mixers (electric and air driven)
- ☐ B-102 Top Entering Mixers (turbine and paddle types)
- ☐ B-103 Top Entering Mixers (propeller type)
- ☐ B-104 Side Entering Mixers
- ☐ B-106 Condensed Catalog (complete line)
- ☐ B-107 Mixing Data Sheet

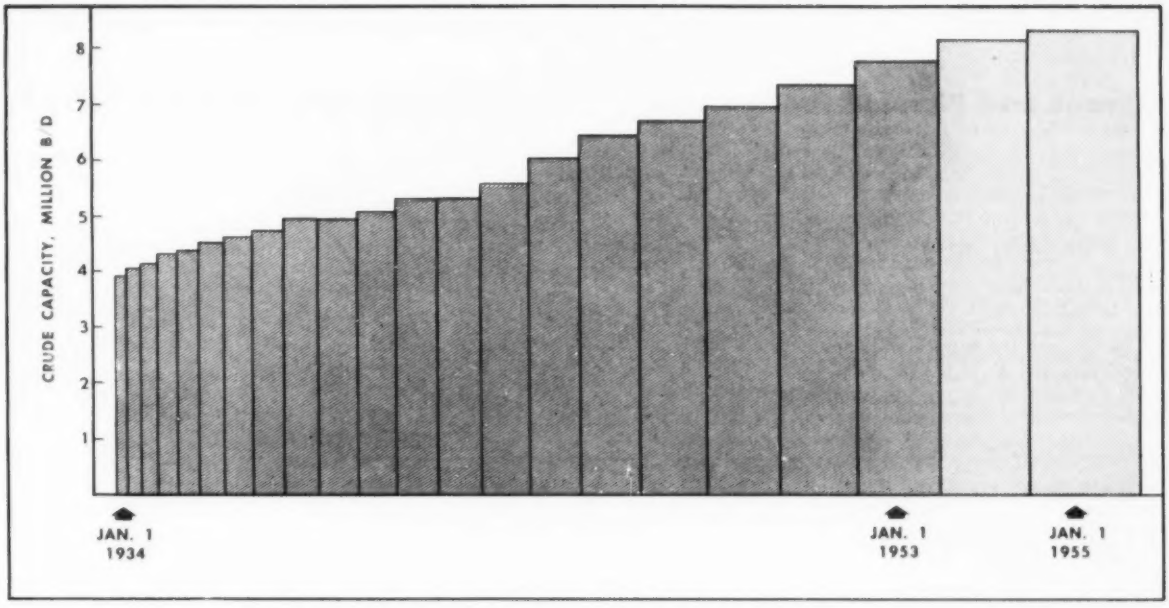
Please send me the catalogs checked at left.

Name_____ Title_____

Company_____

Address_____

City_____ State_____



STILL GROWING — U. S. refining capacity is up 100% in two decades

385,821 b/d New Capacity in '53

PETROLEUM refiners in the United States expect to have an effective crude charging capacity of 8,156,381 b/d by the end of this year, an increase of 385,821 b/d—nearly 5%—over the present capacity of 7,770,560 b/d.

These and other figures on the expected growth of refineries were obtained through questionnaires sent out last August by the Petroleum Administration for Defense to 237 refiners who operate about 350 refineries. The results of the survey were just recently released by PAD.

On the expansion of other process units expected this year, the survey showed:

Catalytic Cracking—Total charge capacity will be increased by 365,693 b/d—or 13.7%—from a present level of 2,675,035 b/d to 3,040,728 b/d.

Catalytic Reforming—Charge capacity of all units (both for gasoline production and for chemicals and solvents) will be increased 136,500 b/d—or 75.9%—from a present level of 180,453 b/d to 316,953 b/d. The bulk of this increase will be for gasoline operations—110,400 b/d, or 87% over the present level of 124,728 b/d.

The survey also included additions to capacity presently planned for completion in 1954. Continued increases in crude charging and catalytic cracking capacity are assured for then. Additional catalytic reforming capacity is also planned—but all of it aimed at gasoline production.

The table below gives a summary of the present and anticipated capacities of all U. S. refineries. The tables on the following page give the same figures broken down according to PAD districts.

Process Unit Capacity of U. S. Refineries

	Capacity (1) After Assured Projected Expansions			
	Jan. 1, 1952	Jan. 1, 1953	Jan. 1, 1954	Jan. 1, 1955
Rated Crude Capacity—BPCD	7,358,862(2)	7,770,560	8,156,381	8,305,941
Catalytic Cracking Capacity:				
Fresh Feed—BPCD	1,991,744	2,199,717	2,497,910	2,649,471
Total Feed—BPCD	2,394,744	2,675,035	3,040,728	3,264,518
Conversion—% on Fresh Feed	54.6	55.1	55.4	55.8
Catalytic Reforming Capacity:				
For Gasoline, BPCD Feed	80,380	124,728	235,128	339,028
For Chemicals and Solvents, BPCD Feed	35,205	55,725	81,825	81,825
Total Light Ends Recovery from All Sources:(3)				
Propylene—BPCD	69,494	81,730	92,669	100,395
Butylenes—BPCD	127,511	142,953	153,718	162,953
Isobutane—BPCD (refinery sources)	109,376	120,064	133,599	146,592
Isobutane—BPCD (normal outside sources)	20,239	20,636	19,618	20,829

Note (1) Capacity means the maximum daily average throughput obtainable with allowance for normal downtime for repairs, etc.

Note (2) As reported in Bureau of Mines annual survey, "Capacity of Refineries and Cracking Plants." * Does not agree exactly with Bureau of Mines figure due to being later information.

Note (3) Recoverable in a suitable stream for possible use as alkylation feed or as chemical feed.

NOTE: The difference between fresh and total feed is accounted for by products that are recycled for use in the cracking process and are not released for general use. In effect the "fresh feed" figure is the equivalent of the figure for products actually made available through the cracking process. Capacity figures refer, not to the theoretical maximum capacity, but to the practical capacity, allowing time for repairs and other unavoidable shutdowns.

Current and Planned Process Unit Capacity, U.S. Refineries, By PAD Districts

PAD District I[1]

	Jan. 1, 1952	Capacity After Assured Projected Expansions Jan. 1, 1953	Jan. 1, 1954	Jan. 1, 1955
Rated Crude Capacity—BPCD [2]	1,213,050*	1,226,900	1,351,540	1,375,550
Catalytic Cracking Capacity:				
Fresh Feed—BPCD	368,740	363,340	481,640	490,490
Total Feed—BPCD	414,090	411,790	566,890	575,740
Conversion—% on Fresh Feed	53.1	53.2	54.5	54.5
Catalytic Reforming Capacity:				
For Gasoline, BPCD Feed	1,500	3,000	22,400	36,750
For Chemicals and Solvents, BPCD Feed	0	0	10,000	10,000
Total Light Ends Recovery from All Sources: [3]				
Propylene—BPCD	12,455	13,608	16,806	16,838
Butylenes—BPCD	23,014	23,516	28,217	28,188
Isobutane—BPCD (refinery sources)	19,452	19,842	24,271	24,283
Isobutane—BPCD (normal outside sources)	1,094	1,226	886	770

PAD District II[1]

Rated Crude Capacity—BPCD [2]	2,042,692*	2,194,192	2,316,992	2,364,942
Catalytic Cracking Capacity:				
Fresh Feed—BPCD	599,674	683,850	767,165	783,865
Total Feed—BPCD	755,446	865,736	947,506	967,216
Conversion—% on Fresh Feed	56.7	56.7	56.8	57.0
Catalytic Reforming Capacity:				
For Gasoline, BPCD Feed	35,530	43,848	74,448	119,618
For Chemicals and Solvents, BPCD Feed	15,205	16,455	16,455	16,455
Total Light Ends Recovery from All Sources: [3]				
Propylene—BPCD	17,506	21,707	22,421	23,579
Butylenes—BPCD	36,326	40,640	42,581	45,022
Isobutane—BPCD (refinery sources)	26,849	30,770	32,104	34,807
Isobutane—BPCD (normal outside sources)	766	1,010	1,786	1,603

PAD District III[1]

Rated Crude Capacity—BPCD [2]	2,674,972*	2,874,603	2,983,984	3,045,034
Catalytic Cracking Capacity:				
Fresh Feed—BPCD	771,718	881,683	970,411	1,027,372
Total Feed—BPCD	898,958	1,047,069	1,156,242	1,256,632
Conversion—% on Fresh Feed	53.6	54.3	54.5	55.7
Catalytic Reforming Capacity:				
For Gasoline, BPCD Feed	31,350	59,880	98,630	143,010
For Chemicals and Solvents, BPCD Feed	17,700	32,970	40,470	40,470
Total Light Ends Recovery from All Sources: [3]				
Propylene—BPCD	29,544	36,251	41,823	46,049
Butylenes—BPCD	51,268	60,528	64,036	68,224
Isobutane—BPCD (refinery sources)	50,277	55,545	62,765	68,937
Isobutane—BPCD (normal outside sources)	14,254	14,030	12,776	14,221

PAD District IV[1]

Rated Crude Capacity—BPCD [2]	255,248*	255,765	257,765	257,765
Catalytic Cracking Capacity:				
Fresh Feed—BPCD	63,462	73,694	84,544	85,594
Total Feed—BPCD	84,600	106,290	119,940	120,780
Conversion—% on Fresh Feed	61.9	64.9	65.0	65.2
Catalytic Reforming Capacity:				
For Gasoline, BPCD Feed	0	0	650	650
For Chemicals and Solvents, BPCD Feed	0	0	0	0
Total Light Ends Recovery from All Sources: [3]				
Propylene—BPCD	2,092	2,887	3,142	3,142
Butylenes—BPCD	3,201	4,017	4,572	4,572
Isobutane—BPCD (refinery sources)	2,871	3,696	4,221	4,221
Isobutane—BPCD (normal outside sources)	150	150	250	250

PAD District V[1]

Rated Crude Capacity—BPCD [2]	1,172,900*	1,219,100	1,216,100	1,262,600
Catalytic Cracking Capacity:				
Fresh Feed—BPCD	188,150	188,150	194,150	262,150
Total Feed—BPCD	241,650	244,150	250,150	344,150
Conversion—% on Fresh Feed	53.1	53.1	53.1	51.8
Catalytic Reforming Capacity:				
For Gasoline, BPCD Feed	12,000	18,000	39,000	39,000
For Chemicals and Solvents, BPCD Feed	2,300	6,300	14,900	14,900
Total Light Ends Recovery from All Sources: [3]				
Propylene—BPCD	7,897	8,077	8,477	10,787
Butylenes—BPCD	13,702	14,252	14,312	16,947
Isobutane—BPCD (refinery sources)	9,921	10,211	10,229	14,344
Isobutane—BPCD (normal outside sources)	3,675	3,920	3,920	3,985

Note (1) Capacity means the maximum daily average throughput obtainable with allowance for normal downtime for repairs, etc.
Note (2) As reported in Bureau of Mines annual survey, "Capacity of Refineries and Cracking Plants."
Note (3) Recoverable in a suitable stream for possible use as alkylation feed or as chemical feed.
* Does not agree exactly with Bureau of Mines figure due to being later information

Double-duty Gas Plant

How one gas recovery unit serves both an old and a new cat cracker

By ARNOLD E. KELLEY and HARRY F. POLL
Union Oil Co. of California

THE Fluid catalytic cracking unit which Union Oil Co. of California placed on stream last July at its Los Angeles refinery contained several features unusual to such an installation. This unit supplements production from an existing Thermofor catalytic cracking unit to more than double the production of total catalytic gasoline in this refinery.

The most unusual feature is the integration of gas recovery facilities for the new 28,500 b/d Fluid unit with those of the existing 20,000 b/d TCC unit. It thus was possible to utilize idle capacity in the existing gas recovery section with a minimum of new equipment and simultaneously to achieve unusual operating flexibility.

The other unusual features also center about the gas recovery plant. These include the installation of a particularly satisfactory pressure control, to minimize "upset troubles" from pressure changes in the depentanizer; and a wash-water system designed to eliminate hydrogen embrittlement and blistering problems in the gas plant equipment.

When Union decided to increase catalytic cracking capacity by supplementing its existing TCC Unit with a new FCC Unit, attention was drawn to existing excess TCC gas plant capacity. This spare capacity was the result of: 1) An original overdesign factor of 20%, 2) Operation at lower conversion levels than originally designed, and 3) change from war operation of cracking and treating to cracking only.

Analysis showed that with the addition of only a de-ethanizing absorber and two new 1,300 hp compressors, all major equipment items would be present for integrated gas plant operation on the reactor products from both cat crackers.

The feed to the integrated gas plant consists of wet gas and unstabilized gasoline produced from the catalytic sections of both the new FCC Unit and the original TCC Unit. Function of the plant is to separate the feed into six product streams: dry gas, propane-propylene, butane-butylene, pentane-amylene, light catalytic gasoline, and heavy catalytic gasoline.

The gas plant can be conveniently divided into three sections for discussion.

The first section, Fig. 1, referred to as "TCC Facilities," receives the wet gas and unstabilized gasoline from the TCC Unit. It processes them through a de-ethanizer and depentanizer to yield a dry gas stream to the refinery fuel gas system, a TCC depentanizer overhead containing the C_5's, C_4's, and C_3's, and a TCC depentanizer bottoms.

The second section, Fig. 2, referred to as "FCC Facilities," receives the wet gas and unstabilized gasoline from the new FCC Unit. In a manner similar to the first section, they are processed to dry gas, an FCC depentanizer overhead and FCC depentanizer bottoms.

The third section (Fig. 3) is referred to as "Combined Facilities," since here the TCC and FCC streams are commingled and processed through common facilities. The TCC and FCC depentanizer overhead streams are combined for processing through a depropanizer and debutanizer to propane-propylene, butane-butylene and pentane - amylene streams. The TCC and FCC depentanizer bottoms streams are combined and fed to a single rerun tower where they are split into light and heavy catalytic gasoline streams.

TCC Facilities

Fig. 1 is a flow diagram of the TCC facilities showing basic control instrumentation.

Wet gas from the TCC Unit is received in a compressor suction knockout drum where entrained liquid is

One Gas Recovery Plant

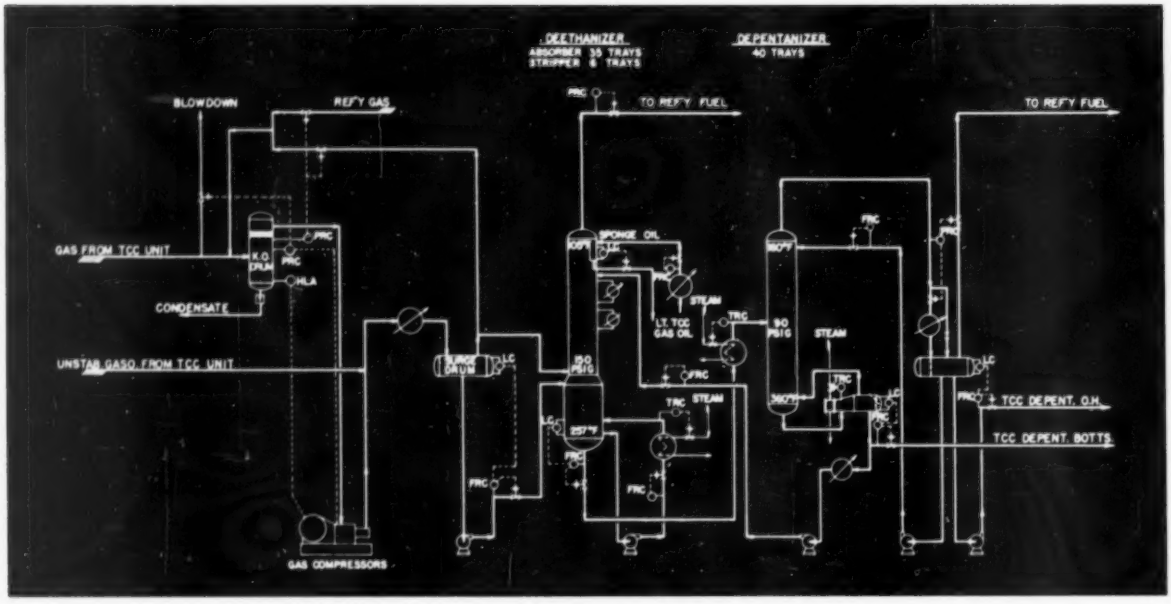


FIG. 1—Flow diagram and instrumentation, TCC Unit facilities

removed by a wire mesh mist extractor. The knockout drum is equipped with a high level alarm and if the level continues to rise, the magnetos of the compressor engines are shorted, thus shutting down the compressors.

Constant suction pressure on the compressors is provided by two pressure recorder control instruments, one for above the control point and the other below. The action on high pressure is to first speed up the compressor and, after reaching maximum speed, to vent gas to blowdown. When the pressure drops, the compressor speed is gradually reduced. If the pressure continues to drop, the second instrument opens first one control valve which recycles compressor discharge and, if necessary, a second which lets refinery fuel gas into the system.

The gas is compressed in two-stage compressors to 160 psig. and joined by the TCC unstabilized gasoline as it flows through coolers to the TCC de-ethanizer surge drum.

Vapors from the surge drum pass upward through the absorber section of the column, contacting absorption oil (depentanized gasoline from the TCC depentanizer). The top five trays are a sponge section where any small quantities of absorption oil carry-over are recovered by sponge oil (light TCC gas oil). Dry gas is produced overhead under pressure control. After scrubbing with diethanolamine for the removal of H_2S, it enters the refinery fuel gas system. Rich sponge oil is trapped out on a sealed pan and returned to the main TCC fractionation system. Two intercoolers remove heat from the absorption section.

Liquid from the de-ethanizer surge drum enters the stripping section of the column and passes downward together with the rich absorption oil. In this section ethane and lighter are stripped from the liquid. A steam reboiler provides heat to the bottom of the de-ethanizer. The basic control instrumentation shown on the diagram in Fig. 1 is a typical installation.

De-ethanized gasoline bottoms flows through a steam preheater into the TCC depentanizer where C_5 and lighter are taken overhead. Heat is supplied to the bottom of the tower by a steam reboiler. A cold reflux (to net product) ratio of about 1.5 is used.

In the redesign by Universal Oil Products Co. of the catalytic gas plant for use with the FCC facilities, a very successful method of pressure control for the depentanizer was employed.

Under normal conditions this tower is operated total condensing. Tower pressure is controlled by a butterfly valve on the overhead vapors flowing to the condenser. The liquid inlet line from the condenser projects downward below the level in the accumulator drum and an equalizing line connects the top of the accumulator to the depentanizer overhead line, upstream of the control valve.

This arrangement establishes a pressure in the accumulator which is equal to that in the tower overhead line, irrespective of the temperature of the liquid in the accumulator drum. If, for example, an upset occurs which tends to decrease tower pressure below the control point, the butterfly valve in the overhead line is throttled until pressure returns to the control point. The equalizing line forces liquid up the line between condenser and accumulator to a height equivalent to the pressure drop across the control valve.

This system permits more rapid response to pressure upsets than does one that requires changing the temperature of the accumulator liquid until the desired equilibrium pressure is achieved. It also provides for more reliable pump suction conditions on the reflux and overhead product pumps. When the tower is producing non-condensibles, however, the equalizing line is blocked closed and the pressure is controlled by a motor valve relieving accumulator gas to the refinery fuel system. This alternate also is shown in Fig. 1.

FCC Facilities

Wet gas from the Fluid unit is received in a knockout drum and compressed to 160 psig., exactly as described for the TCC unit. Fig. 2 is a flow diagram.

The de-ethanizer actually is a double tower, combining absorption (upper section) with stripping. The vapors discharging from the compressors are recombined with overhead from the stripper section and the bottoms from the absorption section giving one additional theoretical

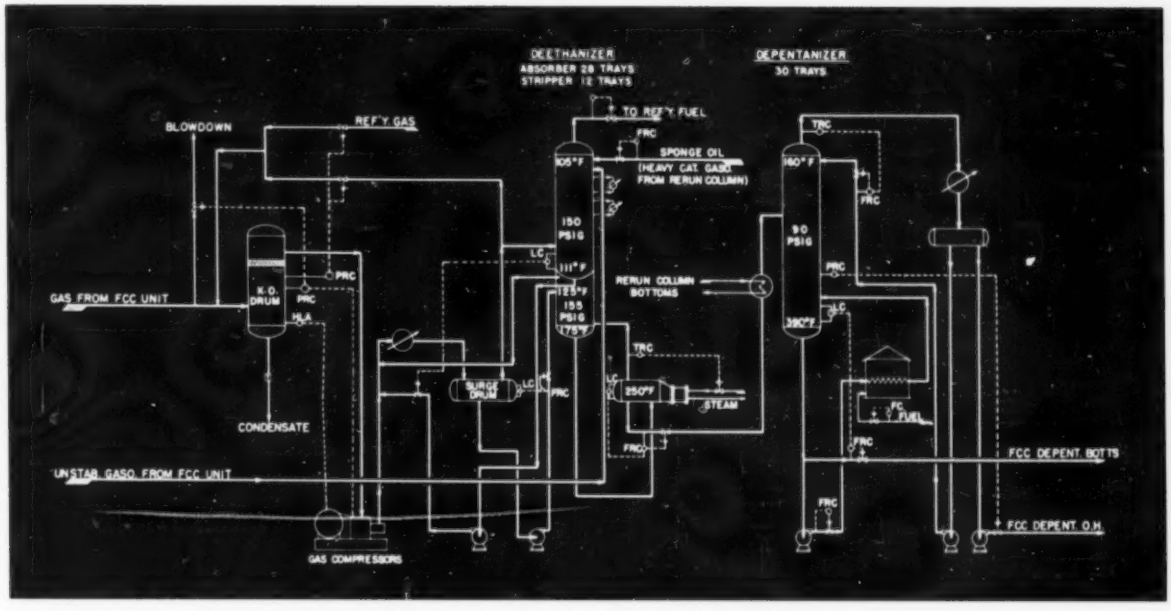


FIG. 2—Flow diagram of FCC Unit facilities

contact. The combined vapor-liquid stream flows through a precooler and into the de-ethanizer surge drum.

The vapors from the surge drum enter the bottom of the absorption section and, in ascending the column, are contacted by the unstabilized FCC gasoline which serves as absorption oil. The use of wild gasoline as absorption oil permits both stripping and absorption in the absorption section, thus increasing the effective height of the stripping section and making possible the production of an ethane-free bottoms. Heavy catalytic gasoline from the rerun unit is used as sponge oil.

The de-ethanizer surge liquid is pumped into the top of the stripper section. Heat is supplied to the bottom of the column by a steam reboiler. Ethane-free bottoms are exchanged against rerun column bottoms to obtain preheat and fed into the FCC depentanizer.

The de-ethanized feed is separated in the FCC depentanizer into pentane and lighter and depentanized gasoline. Heat is supplied by a fired reboiler and a cold reflux ratio of about 1.5 is used.

This column is not yet equipped with the more desirable pressure control system previously described. However, reasonably satisfactory control is obtained by the flooded reflux system shown.

In this system the reflux drum, part of the condenser and the line between them contain liquid. The liquid level in the condenser is varied to expose more or less condensing surface by a pressure controller which throttles the pump discharge of overhead product. Thus, if the pressure rises above the control point, the control valve opens further and more product is pumped away. This lowers the liquid level in the condenser, exposing more surface and thereby reducing pressure to the control point.

Combined Facilities

The combined TCC and FCC depentanizer overhead streams flow through a steam preheater into the depropanizer, shown in the flow diagram of combined facilities, Fig. 3. The liquid propane-propylene overhead stream is split to provide a cold reflux ratio of about 4 and a net production to diethanolamine scrubbing for H_2S removal. Heat is supplied to the bottom of the column by a steam heated reboiler.

Column pressure is controlled by a hot by-pass around the overhead condensers and is a part of the original design. One disadvantage of this control already has been mentioned before: sluggish response because the large inventory of liquid in the accumulator drum must reach a temperature which will give the desired equilibrium pressure.

Depropanizer bottoms is pressured into the debutanizer for separation into an overhead butane-butylene product and a bottom pentane-amylene product. A cold reflux ratio of about 1.5 is used and heat is supplied to the bottom of the column by a steam heated reboiler. The debutanizer is operated on flooded reflux and pressure control, just like the dependanizer.

The combined TCC and FCC dependanizer bottom streams feed into the rerun column or gasoline splitter. The overhead, light catalytic gasoline, is split into two streams. One refluxes the tower with a cold reflux ratio of about 0.6 and the other goes to treating and inhibiting as a gasoline blending stock.

Heat is supplied by a separate section of the same heater which reboiled the FCC dependanizer.

Rerun bottoms, heavy catalytic gasoline, is cooled and then split into two fractions. One is pumped under flow control to the FCC de-ethanizer where it serves as sponge oil. The balance goes to treating and inhibiting also.

The light ends recoveries in this unit are 70% for the propane-propylene, 95% for the butane-butylene and 99+% for the pentane-amylene.

Table 1—Purity of Gas Plant Streams

Component	Stream Composition, mol-% Propane-Propylene	Butane-Butylene	Pentane-Amylene
C_2 & lighter	10.0		
C_3	89.0	1.5	
C_4	1.0	97.5	1.0
C_5		1.0	97.1
C_6			1.9
	100.0	100.0	100.0

One Gas Recovery Plant

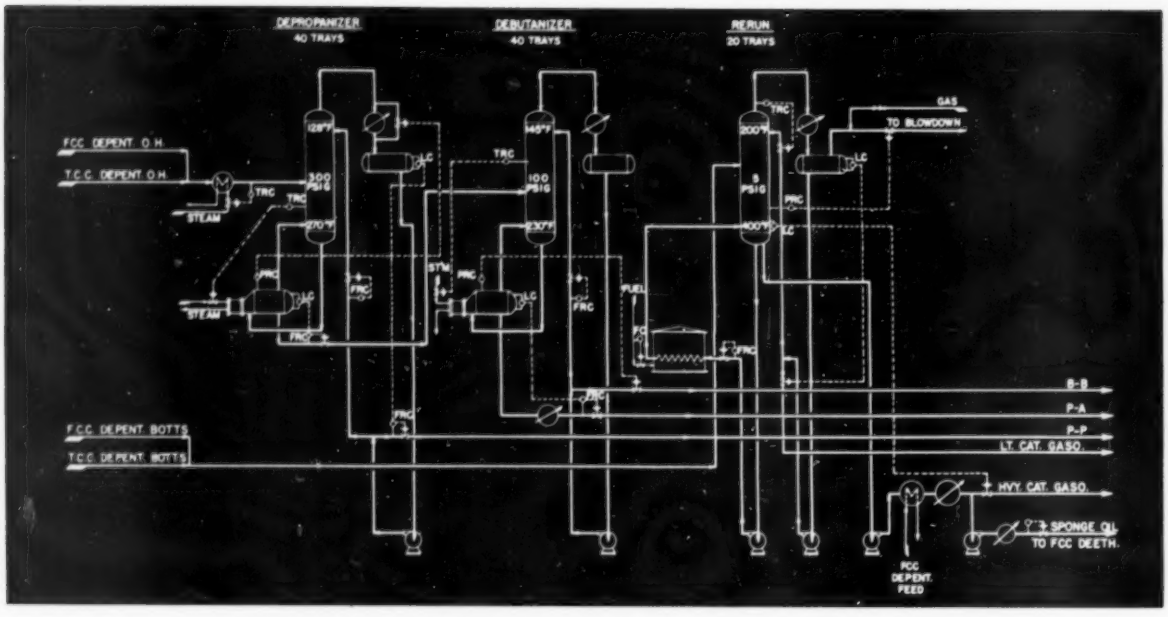


FIG. 3—Combined gas plant serving both FCC and TCC units

Approximate compositions of these streams are shown in Table 1.

Gas Plant Flexibility

Considerable operating flexibility is afforded by a by-pass arrangement which permits continued production of stabilized gasoline in the event that one or more towers are shut down for repairs.

Briefly; jump-over lines permit the by-passing of the TCC de-ethanizer and/or TCC depentanizer, and running the combined feeds through the corresponding FCC towers, or vice versa. Where necessary, production rates have to be cut back to accommodate limiting tower loadings but nevertheless, a costly total shutdown of the catalytic units can be avoided.

This by-pass arrangement also helps in the start-up of either the FCC or TCC units. When either of these units is being readied for a start-up, some of the reactor products from the operating unit can be prematurely by-passed into the gas plant of the other. Thus, the "cold" de-ethanizer and depentanizer can be brought on stream, ready to take over when its own cat cracker starts to produce feed.

When any of the towers of the combined facilities are shut down, that is, depropanizer, debutanizer, or rerun, operation of those remaining can be continued. In some cases it may be necessary to reduce rates.

To illustrate; if the depropanizer were by-passed due to shutdown, the de-ethanizers would be operated to produce propanes overhead to fuel gas. The debutanizer would not be capable of total condensing operation and a propane-rich gas would be pressure controlled overhead from the debutanizer overhead accumulator into the refinery fuel gas system. Liquid B-B would be produced from the debutanizer overhead accumulator drum as normal.

If the debutanizer were by-passed due to shutdown, several alternates are available. Pentanes could be left in the depentanizer bottoms and the combined propanes and butanes then comprising the depentanizer overhead run to butane production. This also by-passes the depropanizer. Another alternate would be to operate the depropanizer on the propane-butane mixture to effect a split between them. In either case, pentanes would be produced with the light gasoline at the rerun unit.

When the rerun tower is down a full-range gasoline is produced.

Operating Difficulties Experienced

A few operating problems have been experienced in the plant.

Compressor cylinder walls were being badly scored in early operations, particularly in the high pressure stage. The problem was attributed to condensation of heavy ends in the wet gas with a resultant "washing away" of the lubrication on the cylinder walls. An attempt was made to find a lubricant which would resist this action and alleviate the trouble, but without success. It was then decided to raise the cooling jacket water temperature to 130°-140° F. from its former 100°-110° F., to minimize condensation. The result was completely successful and no further trouble has been encountered.

Another early compressor problem was an excessive breakage of valves, also predominantly in the high pressure stage. The valves being used were steel, 12% chrome. Several theories were advanced for the cause, including hydrogen embrittlement and liquid entrainment. Although it is not possible to state a definite cause, the problem was eliminated by switching to Micarta plastic valves.

Another early problem was the plugging of instrument lines on the depropanizer resulting in false readings of levels, flow rates, etc. The trouble was quickly identified as due to H_2S hydrate formation and eliminated by steam tracing the instrument lines.

Wash Water System

An important problem with Fluid unit operators everywhere, especially those using heavy California stocks which are comparatively high in nitrogen and sulfur, is to minimize hydrogen attack on the gas plant equipment. This is the function of the wash water system shown in Fig. 4.

Briefly, the attack results from the penetration or diffusion of atomic hydrogen into the metal, where it associates into molecular hydrogen which cannot diffuse out. Internal pressure builds up until failure of the metal results. The atomic hydrogen is liberated from water by galvanic corrosion cells on the metal surface; i.e., it occurs only where moisture is present.

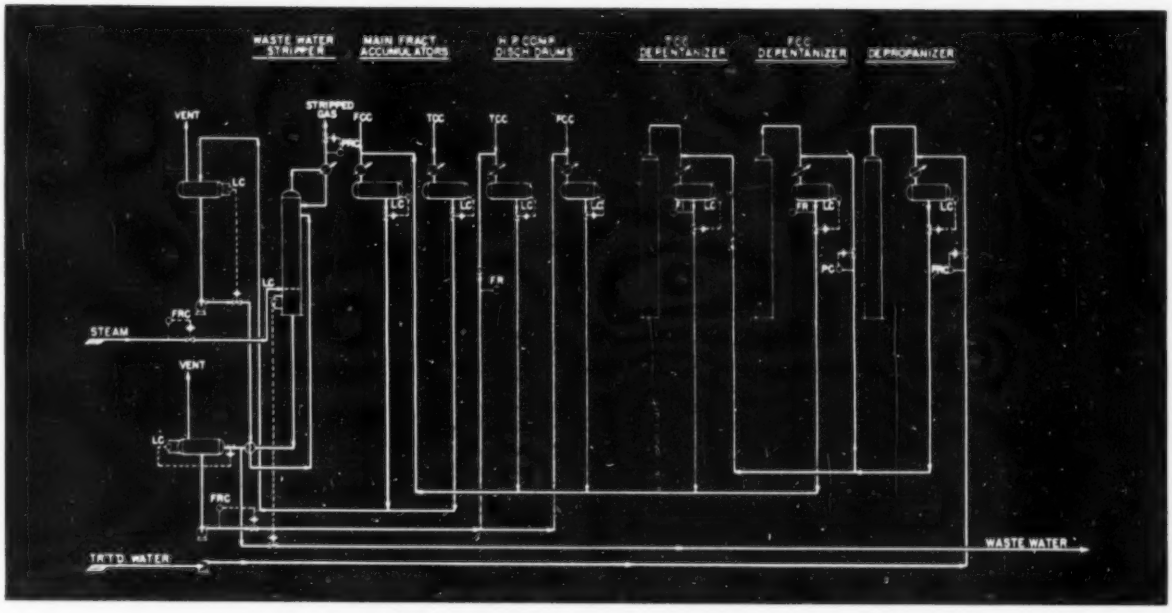


FIG. 4—Flow diagram for water wash system to eliminate cyanides

It has been found that certain ions actively promote the acceptance of atomic hydrogen by metal; one of the worst is the cyanide ion. Unfortunately, the Fluid process apparently converts some of the nitrogen in the feedstock into cyanide ions. For those interested in further details of the mechanism and effect of hydrogen attack, attention is directed to the article by Effinger, et al (PETROLEUM PROCESSING, p. 500, May, 1951; *Petroleum Refiner*, May, 1951).

Two possible solutions to the problem of hydrogen attack consist of either eliminating the galvanic corrosion, or eliminating the cyanide ion promoter. The latter is the more simple and is effected by water washing the hydrocarbon streams for removal of the cyanide ion.

Fig. 4 shows how this has been done in the Union gas plant. Treated water first enters the depropanizer overhead line and collects in the accumulator drum. From the depropanizer accumulator drum it splits into two streams, one to each of the dependanizer overhead lines. From the dependanizer accumulator drums, the wash water flows to the main fractionator column overhead accumulator at the FCC Unit.

A second wash water system uses water from the bottom of the waste water stripper. This stream splits, a portion going to the compressor discharge from each unit. This water collects in the FCC and TCC compressor discharge drums and is returned to the FCC main fractionator column overhead accumulator drum along with the stream from the dependanizer overhead accumulator drums.

The water from the entire system then goes to a settler for oil removal. From there it is pumped to the waste water stripper as shown in the diagram, where it is stripped with steam to remove hydrogen cyanide, ammonia, and hydrogen sulfide. The stripped gases are discharged through steam traced lines into a fired heater and burned.

Meet the Authors

Mr. Kelley

Mr. Poll

Arnold E. Kelley, supervisor of manufacturing process, Union Oil Co. of California, was graduated from the University of Minnesota in 1940 with a B. S. in chemical engineering. He went to Union Oil upon graduation for a temporary summer job, but has remained there ever since.

His first responsibilities were on pilot plant operations, process development, and commercial start-ups for the research development dept. at Wilmington, Calif. In 1943, Mr. Kelley was transferred to the manufacturing group in Los Angeles as operating engineer; in 1945, he went to the refinery process group at the Los Angeles refinery; and in 1946 he transferred to the head office process group.

Harry F. Poll, senior process engineer in the research and process dept. of Union Oil, is a native of Chicago and received his B.S. in Chemical Engineering from Purdue in 1941. He joined Union's research dept. in 1946 after service in the U. S. Navy during the War, and worked in pilot plant and process development until mid-1947, when he transferred to the manufacturing process group.

The accompanying article is based on a paper, "A Review of the Catalytic Cracker Gas Plant at Union Oil Co.'s Los Angeles Refinery," presented at the annual meeting of the California Natural Gasoline Ass'n., Los Angeles, October, 1952.

TOPS in "What's New!"—1952

Here are brief repeats of the most interesting items reviewed in the monthly "What's New!" section during the year just finished. As a service to readers who might have missed them, may not have been receiving PETROLEUM PROCESSING before, or may find them of value in their work, the editors have assembled the "Tops in What's New!—1952" on these two pages.

A code number has been assigned to each item. Readers are invited to use the regular Reply Cards, which they'll find between pages 000 and 000, to request further information about equipment or copies of the helpful trade literature.

New Bubble Tray Design

Turbogrid Distillation Trays by Shell Development Co.; an eight-page descriptive bronchure with technical and engineering information on a new fractionation tray designed for higher capacity at equal separation, lower pressure drop, long tray life, and easier maintenance; consisting simply of a series of transverse slots or bars (See article, PETROLEUM PROCESSING, October, 1952, p. 1447) Shell Developement Co., 50 West 50th St., New York 20, N. Y.

Circle No. **1** *on Reply Card*

Basic Process Control

Fundamentals of Instrumentation for the Industries, Bulletin No. 80-2; 128-page booklet covering the fundamentals of measurement, control, and transmission of variables encountered in industry; with typical applications; illustrated with photographs and engineering drawings. Minneapolis-Honeywell Regulator Co., Brown Instruments Division, Wayne and Windrim Aves., Philadelphia 44, Penna.

Circle No. **2** *on Reply Card*

Flow Meter Handbook

The F & P Variable-Area Flow Meter Handbook, Pub. No. 10596; 40-page booklet giving assistance in the selection and sizing of variable-area meters and including a complete description of the meters, as well as tubes and floats and their comparison with variable-head meters; with calibration data and procedure for altering capacity of a Flowrator meter. Fischer & Porter Co., Hatboro, Penna.

Circle No. **3** *on Reply Card*

Water Conditioning Handbook

Permutit Water Conditioning Data Book; 116-page, leatherette bound book, 5 x 7¼ in., covering such subjects as hydraulics, impurities in water, chemicals used in water treatment, specific gravities and chemical reactions; supersedes the 1949 volume, and contains some 77 tables of information. Permutit Co., 330 West 42nd St., New York 36, N. Y.

Circle No. **4** *on Reply Card*

Caustic Soda

Dow Caustic Soda, Form IC2A/452; 70-page book, newly revised, covering 1) the manufacture of caustic soda, 2) chemical and physical properties, 3) economics involved, 4) methods of handling and storage, 5) technical data, 6) methods of analysis, and 7) first aid treatment for caustic burns. Dow Chemical Co., Midland, Mich.

Circle No. **5** *on Reply Card*

Octane Improvements

Mechanical Octane Numbers, by Earl Bartholomew; 14-page brochure defining mechanical octane numbers with comparisons of performances of a 1950 engine to a 1939 engine, research on combustion and combustion chamber design, advantages and disadvantages of supplementary fuel devices, improvements in fuels. Ethyl Corp., 100 Park Ave. Bldg., New York 17, N. Y.

Circle No. **6** *on Reply Card*

Engineering Economics

Battelle Research in Engineering Economics; 16-page booklet discussing the economics of engineering in relation to management planning, industrial market research, raw materials studies, research planning, research operations, and industrial logistics and location; including case histories. Battelle Memorial Institute, Columbus, Ohio.

Circle No. **7** *on Reply Card*

An Alloy "Fairy Tale"

Alloys in Cooperland, a 26-page little book done in "Alice-in-Wonderland" style, with Disney-like cartoons and drawings, doing a first-rate job of describing the alloy manufacturing industry in all its phases—covering the activities from pattern shop to the shipping dock at Cooper Alloy Foundry Co., Hillside 5, N. J.

Circle No. **8** *on Reply Card*

Bubble Caps and Risers

PSC Light-Weight Processing and Heat Treating Equipment, Catalog 52; 24 pages of engineering data on 270 standard styles of bubble caps and risers for fractionating towers and stills; including drawings for use in determining methods of bubble tray assembly, as well as other process equipment. The Pressed Steel Co. Wilkes-Barre, Penna.

Circle No. **9** *on Reply Card*

Revised Gas Analysis Reference

Fisher Gas-Analysis Manual, 4th revised edition; 60 pages discussing theory of gas analysis, giving details on procedures involved in various types of analyses describing maintenance and operation of the Fisher Unitized Gas Analysis Apparatus. Fisher Scientific Co., 717 Forbes St., Pittsburgh 19, Penna.

Circle No. **10** *on Reply Card*

Pump Works on Vibration Principles

Essentially a centrifugal pump, the new "Vibro-Pump" employs principles of vibration rather than rotation. It will handle liquids containing up to 20% vapor with no loss of efficiency. It is comprised of three parts: 1) a slightly curved shaft extending from a motor coupling, 2) a single unit consisting of the impeller housing and a vane, and 3) the pump housing. Impressed on the curved shaft is a permanently lubricated, frictionless bearing which is permanently sealed in the metal bellows or rubber impeller housing and vane unit. As the shaft rotates, it imparts to the vane an orbital motion. A wave-shaped vane remains in a horizontal plane, scooping liquid from the pump center and pushing it to the perimeter. Hermetically sealed, the pump can handle chemicals, oil, gasoline, etc. In water tests, a pump with a 1½-in. housing and 1-in. impeller orbit, powered by a 1/25 hp. motor at 4000 rpm., developed a 35-ft. head. Bennett Productions, 1507 Walnut St. Phila. 2, Pa.

Circle No. **11** *on Reply Card*

Paint Withstands 1600° F. Heat

"Super-Hot" is a new ready-mixed aluminum paint that, when applied to practically any metal surface, permanently bonds to the surface after subjecting it to heat from 500 to 1600°F. It is guaranteed unconditionally to maintain its brilliance and will not crack, chip or peel. Thermocoupling action promoted by application of heat in excess of 800° F. to a metal object painted with the material makes the object impervious to most solvents. This is said to be due to the transition of the paint from a peripheral coating to an aluminum glaze that is an integral exterior of the painted object. It may be brushed, sprayed, or dipped, and air dries within 30 minutes, after which time heat may be applied. The paint may be applied to rusty surfaces, moderately greasy or oily, although best results are obtained when application is on clean, dry surfaces. Sheffield Bronze Paint Corp., 17814 Waterloo Rd., Cleveland 19, Ohio.

Circle No. **12** *on Reply Card*

Plastic Piping More Effective than Metal

A polyester "Fiberglas"-reinforced plastic pipe has been found by the Navy's Bureau of Ships to be an ideal substitute for copper-nickel and copper-brass shipboard piping systems. Tests show it superior to metal in resistance to corrosion and shock, and lower in intallation and maintenance costs. "Reflin" tubing is available in standard sizes from 4 to 10 in. O. D., with wall thicknesses from 0.030 in. Larger sizes can be had on special order. The pipe has a tensile strength up to 35,000 psi. and a flexural strength up to 65,000 psi. Burst pressures range to 3000 psi. Straight sections are coupled by cemented sleeves. The pipe is resistant to weather, soil, dilute alkali, salts, aliphatic and aromatic hydrocarbons, greases, alsoho's, and gasoline. Temperature stability ranges from −60 to 230° F. It can be worked with standard machine tools. Reflin Co., Dept. B-11, 5825 Higuera, Culver City, Calif.

Circle No. **13** *on Reply Card*

Viscosities Recorded by Ultrasonics

The new "Ultra-Viscoson" employs ultrasonic principles to measure and record viscosities continuously and automatically. An hermetically sealed probe—about the size of a fountain pen—it contains no moving parts and can be operated at conditions up to 650° F. and 10,000 atm. pressure. It can be installed permanently in pipe, process vessels, or used in test tubes and beakers. An electronic computer, which can be located up to one mile away from the probe, indicates viscosity of Newtonian materials from 0 to 50,000 centipoises x gms./cc., in four decades—0/50/500/5000/50,000. Apparent viscosity of non-Newtonian materials can be measured over a much greater range. Ultra-Viscoson Corp., 673 Connecticut Blvd., East Hartford 8, Conn.

Circle No. **14** *on Reply Card*

Centrifugal Pump Needs No Seals

"Chempump" is a new magnetically-driven, combined motor and centrifugal pump which requires no mechanical seals or stuffing boxes. It is designed to overcome many of the usual problems associated with the conventional centrifugal pump in handling corrosive and hazardous fluids. It is expected to find a wide variety of applications in petroleum and petrochemical processing. Essential feature of the pump is that the fluid being handled can come into contact with all parts except the motor stator, which is kept isolated by a non-corrosive, non-magnetic and highly electrical-resistant, stainless steel sleeve in the air gap space between the stator and the rotor. Chempump Corp., 1300 East Mermaid Lane, Philadelphia 18, Penna.

Circle No. **15** *on Reply Card*

"Writing" Slide Rule Handles Ten Jobs

A unique pencil device, the "Writing Slide Rule," will enable its user to do practically everything but peel potatoes. Among the ten functions combined in the single instrument are a telescoping measuring scale, a reading magnifier, a depth gage in inches and centimeters, a detachable straight-edge, concealed eraser and spare pencil leads, a plain and enlarging indicator for the slide rule's A, B, C, D, L, S, T, CM, and IN scales and an optical pocket-clip. Accuracy to the third significant figure is obtained in slide rule calculations. Device is 6½ in. long and weighs 0.8 oz. Device Development Co., 226 West Fourth St., New York 14, N. Y.

Circle No. **16** *on Reply Card*

For news about current new products, equipment, processes, or literature please turn to the regular "What's New!" section in this issue, beginning on page 128.

Heating Tube Failures . . .

By JOHN J. B. RUTHERFORD
Babcock & Wilcox Co.

ORDINARY steel structures are designed on elastic properties, painted for surface protection, and then assumed to be permanent. In a furnace however, high temperatures prevent the use of "paints" and cause a lack of permanence in the basic metal structure.

A furnace for heating oils, chemicals, water or other fluids, is generally built of tubular members in order to minimize fibre stresses. Heat transfer is then focussed at the tube surface in such a manner that the tube surface, at the product outlet end, obtains the highest temperature encountered in the system (except hanger-supports).

In the most modern heating units of this type, the tubing is no longer used in the elastic condition, it cannot be readily "painted" against surface deterioration, and it has a predetermined but limited life. On occasions, this transient life is overlooked. Attempts to build a permanent steel structure for use at temperatures above 700° F., are economically unsound. The ideal life of a furnace should be predicated on the technological permanence of the process or the raw material supply. We will refer to the features which affect deterioration of furnace tube life, especially those which tend towards abrupt failure.

Heating tubes, designated as boiler, superheater, still or heat-exchanger tubes, are defined in numerous specifications[1] of the American Society for Testing Materials. A similar class of product for use at elevated temperatures is to be found in ASTM Piping Specifications A 312 and A 335. These basic specifications are recognized in various state codes and serve as the background for numerous private, industrial specifications. The products covered represent standard dimensions which have been found suitable in furnace design and chemical compositions which have been accepted by the industry on the basis of laboratory and service experience. These specifications describe the acceptable dimensional tolerances, surface conditions, heat treatment, mechanical properties and methods of testing. A point seldom realized is that these material specifications tend to define a product suitable for immediate fabrication rather than suited to ultimate service, and these conditions are not the same.

Carbon steel tubes cover most of the requirements for heating up to 500° F., but occasionally non-ferrous materials are used to meet peculiar corrosion conditions. These tubes are specified of low hardness values, as are ordinarily obtained with low carbon steel but which require tedious annealing in the case of the higher alloy compositions. Such practices as expanding or rolling-in and bending are more easily performed with metal of low hardness. It is generally assumed that steel in the annealed condition is free from internal stresses and therefore is less likely to crack on welding or rapid heating in initial service.

Selection of Material

In order to obtain a fluid at a prescribed rate and temperature, the furnace engineer must be familiar with the specific heat, the flow characteristics and, in the case of organics, the phase changes encountered with variations in temperature and pressure. With these parameters blocked out, he then determines the length and cross-section of the column of fluid to be exposed within the furnace. The length must be broken down to units commercially available. This entails the use of headers or return bends, which restricts the fluid flow and requires a longer column for heating.

After consideration of other details, a basic furnace chamber is designed to contain a number of tubes. Because of the thermal head necessary to drive heat through the wall, the outside metal temperature will be higher, depending on heat release than the product at that location. The product will change at essentially a uniform rate from the inlet to the outlet temperature, but the tubing may be, for example, 250° F. higher at the inlet, and 100° F. higher at the outlet.

The wall thickness of the tube determines its heat transfer rate and its cost. Customary practice dictates the use of ordinary steel tubes up to about 500° F. Above this temperature, a suitable selection is made from among numerous chromium-molybdenum-nickel type alloy steels, depending on estimated attack by furnace gases on the outside and by the product on the inside. The heating unit is frequently divided into segments of differing temperature zones, and a different steel may be selected for each zone.

The next step is generally the most critical in furnace design: the determination of the appropriate wall thickness. The fibre stress resulting from internal pressure is determined from slight modifications of the Barlow or Lame formula, wherein the maximum working stress is selected from available data on rate of creep, creep-rupture, or when other information is lacking, tensile strength at elevated temperatures. Many theories have been written[2] on the flow of metals and numerous fundamentals are well established. However, recourse is still necessary to empirical

ARE THESE YOUR TUBE PROBLEMS?

- Hardness losses—de Florez heater
- Collapsed at the end—Polyform unit
- Distorted and brittle—delayed coker
- Welds fail from cyclic heat
- Thermal shock—catalyst cooling coil
- Local overheating—heavy oil heater
- Inside carburizing with heavy coking
- Sour gas attack—catalyst cooling
- Salt corrosion—catalyst cooling coil
- Sulfuric acid attack—SO_2 removal

. . . Cause and Prevention

tests[3] such as covered in recent resumes by the ASTM-ASME High Temperature Committee.

Earlier high temperature data were based entirely on the creep rate, 1% extension in either 10,000 or 100,000 hours. This compares somewhat with measurements of elongation in a structure which is expected to be elastic in behavior. The more recent trend is towards the use of creep-rupture data. The equipment for measuring these two sets of properties is essentially the same, but the latter is carried on to failure. The designer is more prone to apply a safety factor against a known end point, i.e., destruction, than some indeterminate but intermediate point. Then there is the embarrassing feature that some of the "superalloys" on extended test time, do not elongate as much as 1% before failure occurs.

Andrade[4] has shown that creep in shear may lead to less deformation than creep in tension. Since a tubular element invokes a triaxial stress distribution which involves some creep in shear, the elongation at rupture might be less than that measured in the laboratory on a simple tensile-type specimen. This same author finds creep on interrupted loading to be higher than creep on constant loading. Only in the idealized laboratory test is it possible to contain unvarying conditions.

There is a pronounced scarcity of information on high temperature fatigue, as was recently noted by Dolan.[5] It is quite difficult to perform fundamental studies involving cyclic loading at elevated temperatures, since stresses applied to a specimen are computed on the basis of elastic theory, whereas the presence of creep invalidates the basic assumption on which the flexure formula was derived.

From the limited test data and observations in the field, it seems a safe premise to consider high-temperature fatigue as analogous to corrosion fatigue mechanism. This implies that, at a temperature at which creep is operative, a steady or single cycle of load will cause deterioration to rupture in a determinate time; repetitious loading will decrease the cumulative time. Again relating this to still tubes, these will waste away by corrosion and scaling under conditions of no load. The application of stress accelerates wastage, and if the load is cyclic, there is a still further acceleration.

Good mechanical design calls for the use of liberal fillets and freedom from notches. High temperature design is no exception to this rule. Recent studies[6] have shown that even very sharp notches have little effect on the creep rupture strength of a material which, in the absence of the notch, exhibits high ductility. With many of the superalloys, however, where ductility was found to be less than 5% elongation, notches materially decreased the creep rupture strength.

There has been frequent postulation on the nature and mechanism of creep rupture. If a test could reproduce failure in 1000 hours, in what condition was the metal after 900 hours? Again analogy might be made to the mechanics of fatigue failure. Wilder and Ketterer[7] have shown that steels exposed for 10,000

Meet the Author

Mr. Rutherford

John J. B. Rutherford is chief metallurgist, Babcock & Wilcox Co., Tubular Products Div., Beaver Falls, Penna. His metallurgical activities have covered a period of more than 20 years, including similar positions with American Chain & Cable Co. and the U. S. Steel Corp.

They have been related in a large part to the studies and application of stainless and heat-resisting steels. He did considerable background work on the fundamental studies of heat-treating behavior at the U. S. Steel Corp. Research Laboratory, aimed at application of such steel to mechanical tubing where high strength requirements are essential. A large portion of his career has been spent in the development of tubular materials for the oil, chemical, boiler, and automotive industries.

Mr. Rutherford is a native of Hamilton, Scotland and received his education at the Heriot-Watt College in Edinburgh. He is the author of numerous technical publications and a member of American Society of Mechanical Engineers, American Iron & Steel Institute, American Society for Testing Materials, American Petroleum Institute, and several other British and American technical societies.

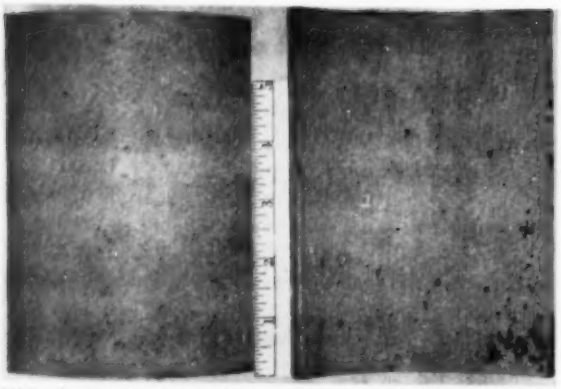


FIG. 1—Inside and outside surfaces of steel heater tube after 85,000 hrs.' service

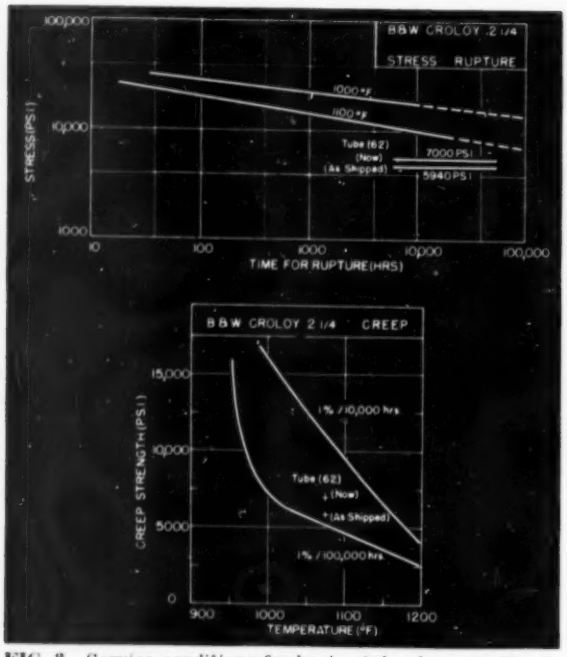


FIG. 3—Service conditions for heater tube shown in Fig. 2, correlated to creep rupture chart (above) and creep chart (below)

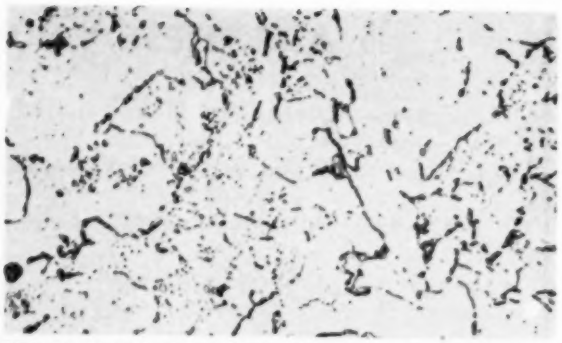


FIG. 2—Structure of Croloy 2¼ tube after 73,000 hrs. service in a Polyform furnace (X1000)

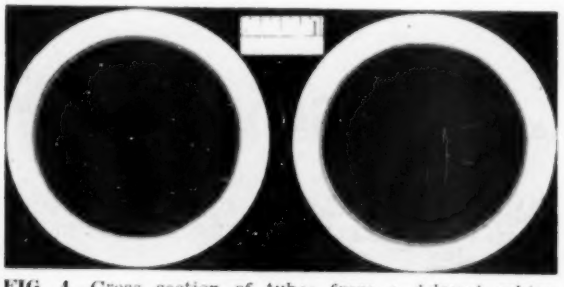


FIG. 4—Cross section of tubes from a delayed coking unit, showing a carburized layer at inner surface

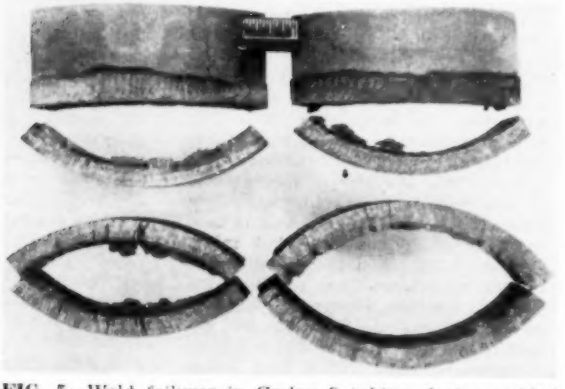


FIG. 5—Weld failures in Croloy 9 tubing, fusion welded with Type 310 rod, after 15 months' service

hours to the maximum stresses allowed by code subsequently yielded the same creep rupture strength as materials exposed without stress and also new materials. It seems that, in the absence of measurable deformation or metallurgical change, material after service is as good as new.

The quantity of oil that can be heated in a single length of tube is not very great. The maximum length of commercially straight tube is about 40 ft. To heat economically within a combustion chamber, it is necessary to have numerous lengths of tubing, in the order of about 100. This calls for connections at the end, which may be of the hand-hole, header type to permit entry for periodic cleaning, or welded return bends if the product is self-flushing, or if thermal decoking is practiced.

With the use of headers, the ends of the tube may be upset so as to reinforce the wall which is thinned by expanding. Whether upset or not, the ends of the tube should be a good fit to permit seating without over-rolling. The header seat is generally grooved, some question the benefit of more than one groove, and the header material should be about 40 numbers higher on the Brinell hardness scale to insure good seating.

Welding of return bends or safe-ends is generally done in the shop with good facilities for preheating and stress-relieving. In the field, it may be necessary to compromise and especially with the deeper hardening alloy steels, it is necessary to take due precautions.[8] Good welding technique is even more necessary for materials used at elevated temperatures, even though there are some advantages where the stresses will be dissipated during service.

Service

In spite of all precautions that are taken in design, heater tubes will fail in service within the prescribed life of the unit. It is the purpose of this paper to describe representative causes of failure, with enough background evidence to help prevent recurrence. These clinical cases have been collected over many years and it has been observed that the earlier cases of flagrant overheating have given way to the more prevalent failure from chemical change, either corrosion wastage or change in the metal composition. The high produc-

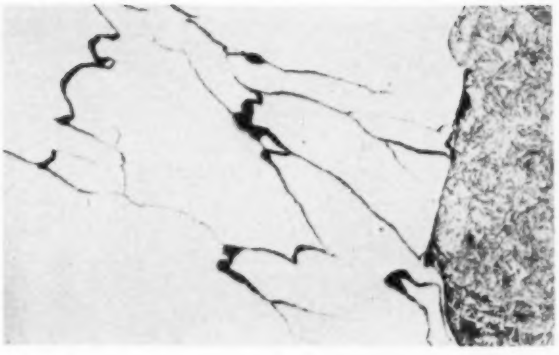


FIG. 6—Left: weld metal in Fig. 5, showing cracks and base metal (etched, X100)

FIG. 7—Above: Croloy 5 heater tube, cracked adjoining Type 310 weld deposit

tion demands of the past few years have been quite severe on equipment. The furnace operator naturally tries to get maximum production, possibly to the extent of gambling on continued functioning. A failure in an oil still, unfortunately, does not end when one or two tubes have been taken out and replaced. The tubes which are left in the furnace may have been warped and may have suffered less obvious damage. These effects are cumulative and the tube which is cracked in straightening after a fire may continue to give satisfactory service, but ultimately the life of the tube has been reduced.

As a background to the examination of failures, it must be recognized that the great majority of heater tubes do not fail in service, they are retired from obsolescence. Many stainless steel cracking still tubes, after 20 years of satisfactory service, wind up as truck guards around refinery fire hydrants: some still see service after 25 years.

Examination Prior to Failure

We have had numerous opportunities to examine heater tubes removed from service during furnace alteration or failure of some other component. These provide an excellent study and are a guide of what may be expected in the absence of unusual variations.

An excellent case was submitted earlier by this author,[9] of a 5 x ⅝ in. wall still tube, 2¼ Cr, ½% Mo, after 11 years service carrying oil at 1000 psi pressure, at 1020° F. During that time, from ⅛ to ¼ in. thickness was lost from the wall, mainly as a result of mechanical cleaning.

Turbining to remove coke abrades particles of metal and under extreme conditions can cut through the wall. This tube had excellent ductility and was in every respect suitable for continued extended service. However, it was approaching the point where bulging could be expected because of wall-thinning. To prevent this, it would be necessary to reduce the temperature or pressure of the operation.

Fig. 1 illustrates the inside and outside surfaces, after cleaning to remove scale and deposit, of a carbon steel tube after 85,000 hours service in a Houdry cracking unit heater. This sample was submitted for routine laboratory examination to determine if it was suitable for further service at 750 to 800° F. The wall thickness was reduced from a nominal .375 in. to .220 in. and there was evidence of some localized pitting at the inside surface which reduced the wall thickness by another .030 in. in these areas. This tube, with the exception of wall thickness, met all the requirements of the original specification and exhibited no change on metallographic examination. Since service involved low pressures, the tube could continue to a calculated life.

Another carbon steel tube was submitted for routine examination after 5 years service in a Deflorez heater. This material was found to be Rockwell Hardness B 40-45, by comparison with the hardness B-60-75 generally found in a hot rolled tube. Metallographic study showed a very coarse grain structure at the outer surface which apparently is the result of cold work followed by heating in the range 850 to 1000° F. It is believed this tube has been hammered periodically to remove scale for inspection of diameter, and that the affected areas yielded pronounced grain growth. In this case, the tube appeared to be sound and good for extended service, yet the properties had changed to such an extent that a considerable risk existed in continuing at the same temperature and pressure.

In maintenance of some Polyform unit furnaces, samples of Croloy 2¼ (2¼% chromium, 1% molybdenum) were submitted for examination. These tubes had seen various service life and had been removed either for corrosion wastage at the ends or collapse at the ends by coke depositing in the tube-seat. The tube described here had been in service 73,000 hours, heating oil to 920° F. at 1400 psi pressure. The metal temperature in this tube was estimated to be 1010° F. Fig. 2 represents the structure observed in this tube, which is similar to the original, so no pronounced change had occurred. This coincided with the fact that tensile properties were typical of the original annealed tube. Fig. 3 is plotted from the stress rupture properties of this steel. At 1075° F. failure will occur in 75,000 hours (the life of this tube) at a fibre stress of 10,000 psi. The original tube obtained a fibre stress under 6000 psi, which because of wall thinning, has increased to 7000 psi. It is obvious that this tube can be built up at the ends and continue safely in service for a calculated period.

Tubes from a heater furnace in a delayed coking unit were removed during overhaul, because of excessive distortion after 20,000 hours, and were studied to determine suitability for continued service. These were Croloy 9 (9% chromium, 1% molybdenum), 3¼ x ⅝ in. coking coils with oil temperatures of 690° F. inlet to 915° F. outlet, and pressure 400 psig. inlet to 40 psig. outlet. Metal temperature was allowed to build up to 1300° F., at which time thermal decoking was practiced. Since these were subjected to radiant heating, it was recognized that, locally, temperatures above 1300° F. may be attained. Fig. 4 shows a cross section of the tubes, and a pronounced carburized layer, about .040 to .070 in. deep, at the inside surface. A section of this tube was squeezed in a press and cracked through the wall with little or no deformation. However, when a similar sample was heated to about 1300° F. and flattened, it exhibited an ability to deform, which might be compared to the original metal. Here then, were tubes which seemed satisfactory on casual inspection but which were glass-hard and would never have withstood the straightening operation necessary before re-installing in the furnace. With the precaution of heating prior to working, these tubes could continue to give useful service.

Failures From Mechanical Causes

This is intended to cover failures which are ruptures resulting from the localization of stresses. At high temperatures, the distribution of stresses is different, primarily because of the phenomenon of relaxa-

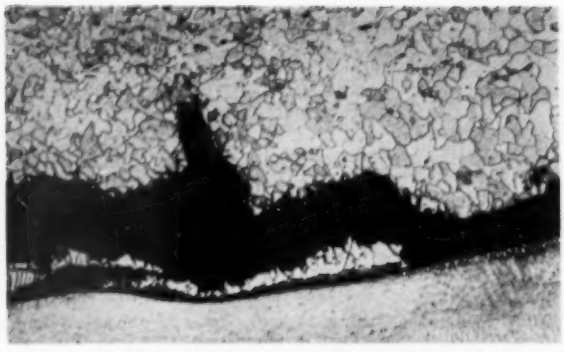


FIG. 8—Position of the fracture shown in Fig. 7 is in the base metal (shown etched) and not in the bead (X250)

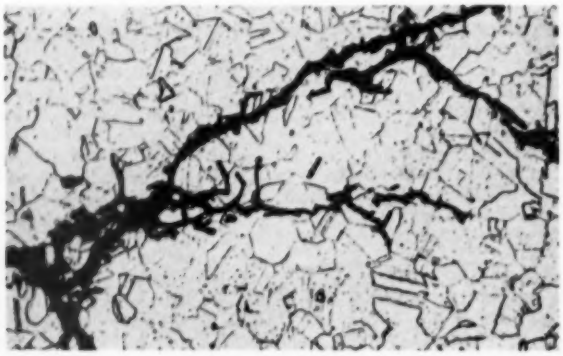


Fig. 10—Transgranular type of crack in cooling coil tube shown in Fig. 9 (X500)

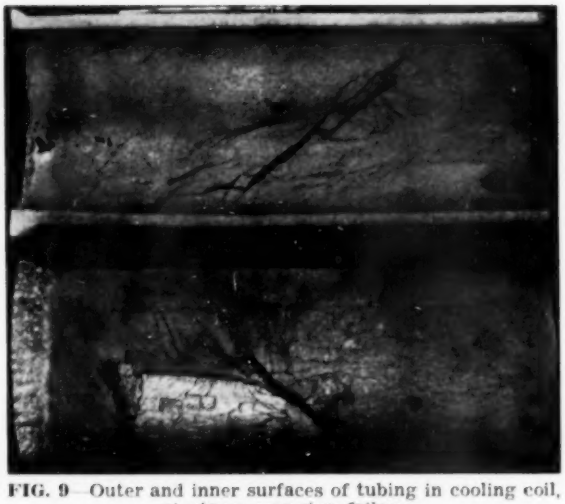


FIG. 9—Outer and inner surfaces of tubing in cooling coil, at stress-corrosion failure

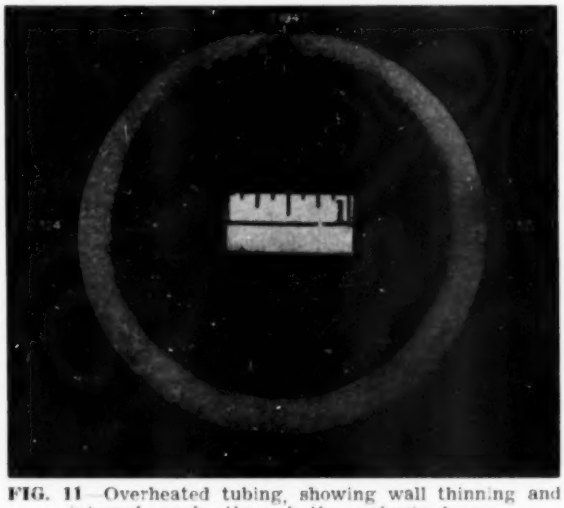


FIG. 11—Overheated tubing, showing wall thinning and internal cracks through the carburized case

tion. A notch type defect which would result in low ductility to rupture at ordinary temperatures, may have no such effect if stresses are dissipated and the bottom of the notch rounds out. The transition from ductile to brittle impact tests at subzero temperatures is well recognized in ordinary steel. Similar transitions occur with other properties and other steels at higher temperatures. Experience alone can detect which features will generate a stress raiser at elevated temperatures.

Cracks in the original material should be culled out. In an oil heating furnace, for example, especially fine inspection must be applied, since the hazard on failure is so high. A field weld is much more difficult to inspect, and this represents one of the major causes of failure. Fig. 5 shows some weld failures in Croloy 9 tubing, fusion welded with Type 310 rod (25% chromium-20% nickel), after 15 months service heating oil at 600 psi. pressure and 400° F. Fig. 6 is a photomicrograph to illustrate these cracks in the weld deposit metal, but which do not run into the base metal (shown etched).

It has been common practice to use an austenitic stainless rod around the refinery since this yielded a deposit of higher strength and better corrosion resistance than the surrounding material. The austenitic material is liable to have a dendritic, low-ductility structure, as in this case, or else be much stiffer than the base metal so that they part after cyclic heating as in Fig. 7. This is a Croloy 5 tube which was salvaged by welding with Type 310 rod, and then placed in service in a box type furnace, heating topped crude and heavy gas oil at 300 psi and 850° F. Metal temperatures were estimated to be 1200-1300° F. and on maintenance shut-down after less than a year in service, a leak was observed.

On removing the tube, the weld fell apart. Fig. 8 shows the position of the fracture which is in the base metal (shown etched) and not in the bead. On the basis of frequent failures of this type, where austenitic welding rod is used with ferritic materials, a welding rod of similar composition to the base metal, to afford a homogeneous weld, is recommended for service at elevated temperatures and especially when subjected to cyclic or fatigue loading.

Fig. 9 is the inside and outside surface of a Type 347 stainless tube, 2⅜ x 0.120 in. which failed in service as a cooling coil in a TCC kiln. This coil attains temperatures about 1200° F. in the kiln when out of service but the sample part containing the failure, from outside the kiln, was at about 200° F. when out of service and 460-475° F. when generating steam. The water being heated in order to cool the catalyst evaporated to leave higher concentration of salts. The corrosion condition thus affected, combined with the extremely severe thermal shock, repeated about 40 times in this case, combined to cause a stress corrosion failure. Fig. 10 shows the transgranular type of crack in this case, demonstrating that the stress factor was greater than the corrosion factor.

This type of failure is not confined to austenitic steels. Tubes of Croloy

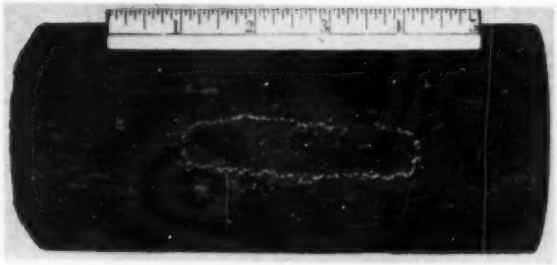


FIG. 12—Outside surface of the tube in Fig. 11, showing manner in which bulky scale flaked off at location of failure

FIG. 13—Effect of uniform and non-uniform heating on tubes from a naphtha reforming furnace

1¼ failed in a catalyst cooling unit, by cracking at the location where they were rolled-in to fittings. The cooling bed temperature at this point was about 1050° F. and the water to the coils was fed or stopped to control this range. The fittings were relatively rigid by comparison with the tubes so that, as the tubes changed in temperature, they acted like a bimetal element with bending forces acting about the seat as a fulcrum. Again, stress played a much larger role than corrosion in this failure.

A Croloy 7 tube, 3 x 0.313 in. failed after 43 days service in an equiflux heavy oil heater, as shown in Fig. 11. This tube had been badly overheated on the rupture side, as evidenced by the amount of scale on the outside, the metallographic structure, and the carburization on the inside. The radial cracks at the inside surface show evidence of the brittle nature of the carburized case and the cracks, when once initiated, served as stress raisers in a progressive manner. Fig. 12 is the outside surface of the same tube at the location of failure and shows the manner in which the bulky scale flaked off.

Another case of local overheating brings out a number of interesting features. Croloy 5 tubes, 5 x 0.500 in., from a naphtha reforming furnace, are shown in Fig. 13. Of these two tubes, one is normal while the other has bulged and thinned at one side. Fig. 14 shows the rupture which was a little removed from the thinned section just shown. The heavy wall at the centre, tapering to the point of fracture, is readily evident. These tubes were only in service about 240 hours but during this time, considerable change occurred in the microstructural components. From the absence of evidence of austenite, the operating temperature could not have exceeded 1500° F., but the existence of a carburized zone in such a short period is evidence that the metal was considerably above 1200° F.

Fig. 15 shows the relation between temperature and stress causing rupture during this service life. With the stated pressure service, failure could be anticipated in these tubes

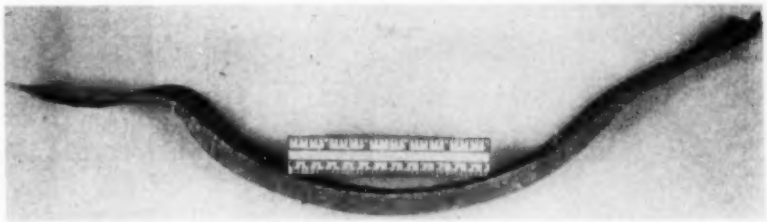


FIG. 14—Cross section at rupture of one of the tubes shown in Fig. 13

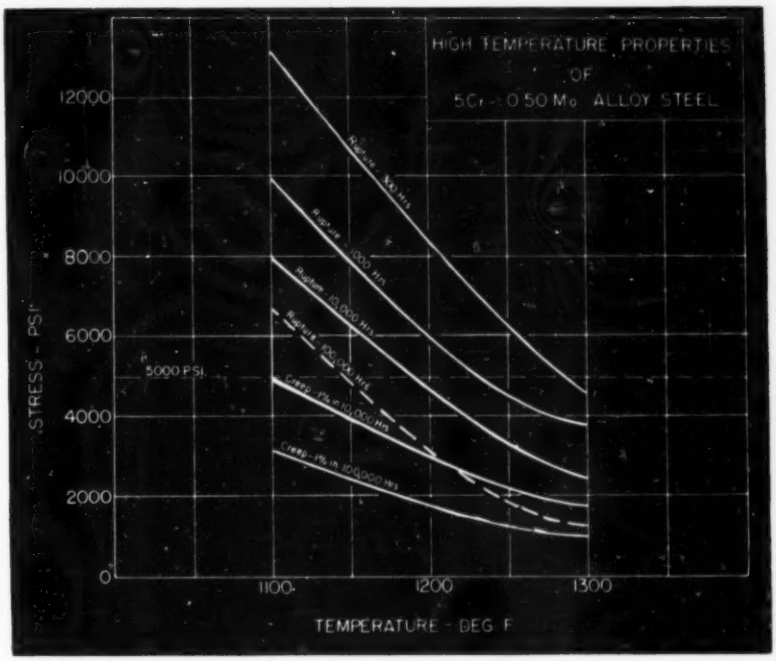


FIG. 15—Relationship between temperature and stress causing rupture

in 300 hours at a temperature of 1300° F., and in shorter periods at higher temperatures. The metallographic structure at the point of failure, Fig. 16 is typical of that obtained when rupture is associated with rapid flow of metal.

Failures From Chemical Causes

The major cause of chemical attack on steel at elevated temperatures, is oxidation. This is generally represented as a wastage of the metal which can be checked by calipers and can be forecast with reasonable accuracy. There is no defense against regular oxidation except to operate at a lower temperature or to resort to higher alloy steel, usually higher in chromium content. Heater tubes suffer oxidation at the outer surface from exposure to combustion gases. The inside surface, in the oil or petrochemical industries,

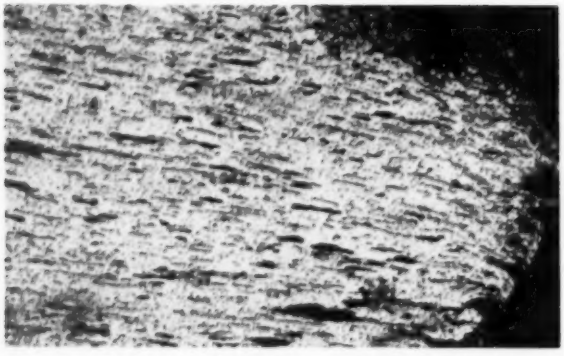


FIG. 16—Distortion of grain structure at point of failure of tube shown in Fig. 14 (X100)

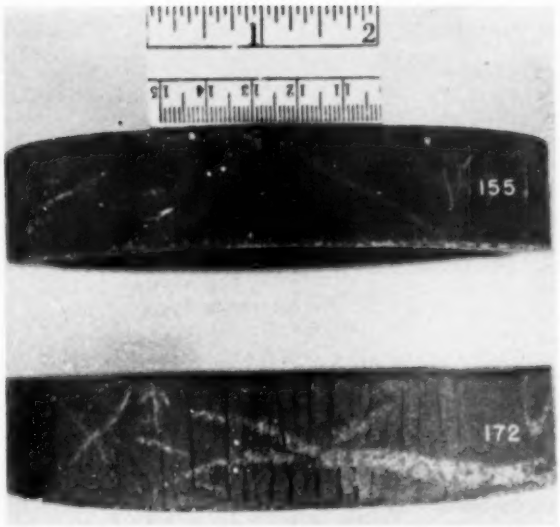


FIG. 17—Heavy external scaling on tubes after 40,000 hrs. service. The scaling was at the thinnest point on the wall

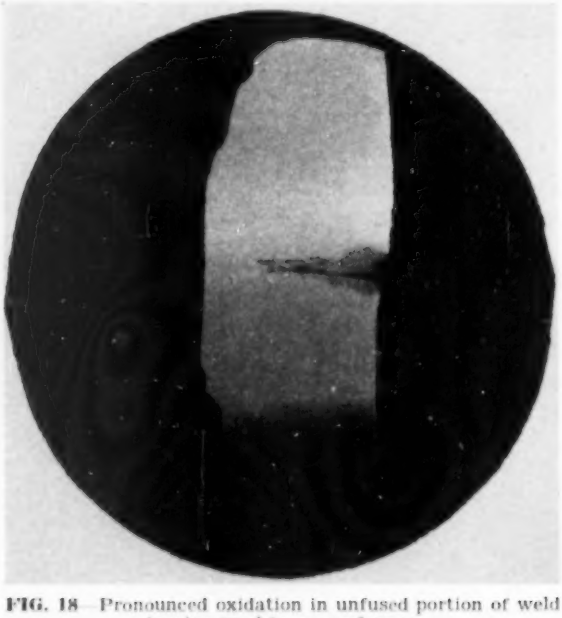


FIG. 18—Pronounced oxidation in unfused portion of weld in pipe used in gas reformer

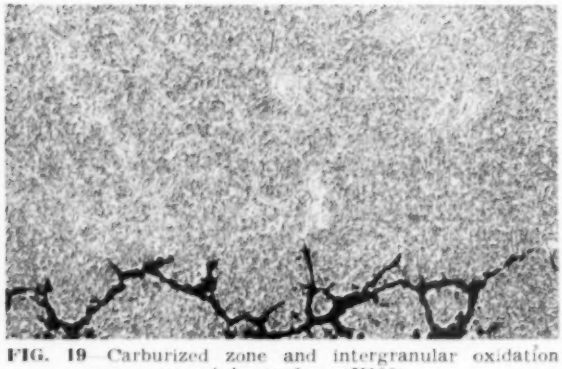


FIG. 19—Carburized zone and intergranular oxidation near tube surface (X100)

is frequently carburized, which might be considered as the opposite from oxidation. Fig. 17 shows the external appearance of Croloy 8 tubes, 5 x 0.500 in., after 40,000 hours heating oil to 1000° F. at 1000 psi pressure, at an average heating rate of 6,700 Btu/hr/sq. ft.

There was heavy coking in this unit and, in combination with high heat input, the metal temperature on occasions must have been quite high. Metallographic evidence established that the side of the tubes illustrated here had been above 1500° F., but it is not known for how long.

After shot-blasting to remove the scale, the pattern still remained and the cracks in the scale were transposed to the metal to become stress-raising notches.

The rate of scaling may be expected to vary along a length of tube, merely from nonuniformity of temperature. There are other factors[10] which affect rate of oxidation, as illustrated in Fig. 18. This is a transverse view through a longitudinal weld in Type 310 (25% chromium-20% nickel) pipe made by rolling and welding plate. The weld covers the outer surface and the crack actually, lack of penetration represents the inside surface. The pipe was used in a gas reformer where steam and methane are reacted at 1450-1650° F. This metal composition successfully resisted oxidation at the exposed surface, yet at the fayed surfaces there is pronounced attack.

This same phenomenon, where a crack or notch acts to catalyse chemical reactions, has also been noticed to affect carburization. In another instance where a Type 310 tube failed in gas reforming service, there was observed the peculiar instance, Fig. 19, of the metal being carburized, which destroyed its resistance to oxidation, and then subsequently failing by oxidation. This photomicrograph illustrates the massive formation of carbide phase, and also intergranular oxidation. The latter, naturally, has a pronounced effect on the mechanical properties of the metal.

Metal wastage occurs from causes other than oxidation. Any chemical reaction which converts the metal into a salt contributes to attrition. Sulphur attack or sulphidization is quite common, especially with nickel-bearing alloys exposed to gases containing H_2S. Fig. 20 is 2¼ x 0.220 in. Type 304 tubing after service in a catalyst cooling coil. Water was fed through the coil when the catalyst bed was too high in temperature, but otherwise the coil was dry. During this time, water fed in through a leaky valve, evaporated and left a salt-residue which melted and attacked the metal. The chemical analysis of this salt corresponded closely to the salts used in water treating.

A very specific form of corrosion is repersented in Fig. 21. This was obtained from a 6 in. pipe, Type 316 (16% chromium, 13% nickel, 3% molybdenum) used for cooling gases from a combustion chamber to remove SO_2. The gases, inside the pipe,

FIG. 20—Attack by salts resulting from evaporation at inside surface of tubing in catalyst cooling coil

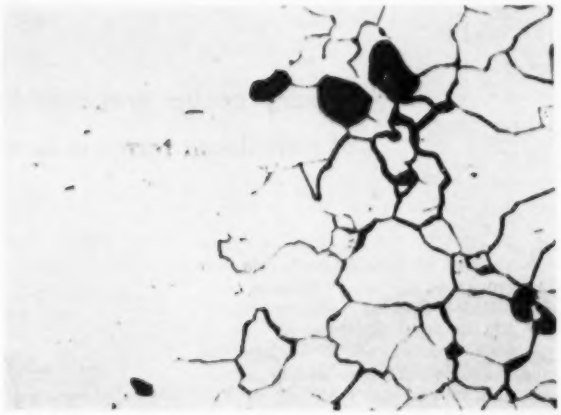


FIG. 21—Intergranular attack progressing from inside surface of pipe used for cooling gases to remove SO_3 (X100)

start at 1300-1700° F., while the outside is exposed to atmospheric conditions. At some time, presumably in intermittent service, this section of the pipe had been hot enough to obtain an intergranular precipitation of carbides, and then subsequently cold enough to obtain a sulphuric acid condensate. This combination resulted in intergranular corrosion in which the metal between the grains is completely removed. The causes and prevention of intergranular corrosion in austenitic stainless steels has been well established[11] and, as a result, this type of failure is now encountered quite infrequently.

Many of the metallurgical causes of failure in heater tubes have already been documented by the author[9]. These steels are placed in service in the annealed condition on the presumption that this is the most stable condition; however, such is not always the case.

For example, plain carbon steel and practically all the carbon-molybdenum steel, on exposure in the thousands of hours to temperatures from 800-1300° F., will suffer conversion of the iron carbide phase to elemental carbon, in the form of graphite. Fortunately, this has little effect on the properties at elevated temperatures unless the graphite occurs in continuous chain form at the grain boundaries. In these cases there is a pronounced detrimental effect on ductility and resistance to impact. As an intermediate step to graphitization, the carbides will coalesce or spheroidize. This has no significant effect but does help to interpret temperature conditions during service.

On heating carbon steel to still higher temperatures than those in which spheroidization and graphitization prevail, the metal will pass through the critical or transformation range and form, in whole or in part, the high temperature modification—austenite. This phase has higher strength and is desirable, but it only occurs at temperatures where steel rapidly wastes away by oxidation.

The addition of alloying elements to steel, such as 18% chromium plus 8% nickel, stabilizes the austenite to lower temperatures where it is useful, and also decreases the rate of oxidation to permit use of the metal at higher temperatures. When carbon steel has been heated to excessive temperatures to form austenite, and then cooled rapidly, the austenite transforms to martensite, the hard brittle constituent associated with hardened tool steel. A heater tube exposed to such conditions, is very likely to be cracked, and, if not, must be cautiously annealed before it is returned to service. The same precautions are naturally necessary if a tube has been repaired or sealed in a header by welding.

The alloy steels which are used because of their high strength at elevated temperatures, fall into two categories, viz. those which are austenitic and those which are precipitation-hardened. The austenitic steels in this class are all high in chromium content and may be susceptible to sigma-phase formation. Special steels, both austenitic and ferritic, have been developed which are age-hardened or precipitation-hardened in order to acquire high strength in particular temperature ranges. The behavior of these steels is quite complex and they should only be utilized under expert advice.

There are many features with which the furnace engineer should be familiar in order to obtain maximum utility of the furnace he designs. A few of these have just been described, but there are many more, and then there are combinations of such a manner that each failure is somewhat unique and offers lessons for the future.

Failures can generally be associated with one of the three broad classifications:

1. Wrong Material Selection
2. Fabrication Defects
3. Overheating

Assistance for the first two are offered in the trade journals, the technical bulletins and in technical assistance available from the tube manufacturer. As for the third, replace-

Acknowledgement

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Know Your Oil Words

Library group prepares list of glossaries of petroleum terms in common use today

AN UP-TO-DATE list of glossaries of petroleum terms has been compiled by the Petroleum Section of the Special Libraries Assn. The list includes 92 titles of specific articles, periodicals, dictionaries, glossaries and the like which include information on the meaning of the petroleum industry's terminology.

While no attempt was made at completeness, it is believed that the list includes the principal glossaries which were available at the time the list was prepared last year, as well as some little known sources in specialized fields in the petroleum industry.

Members of the association helped in the compilation by submitting titles from their own files, together with such annotations as were readily available.

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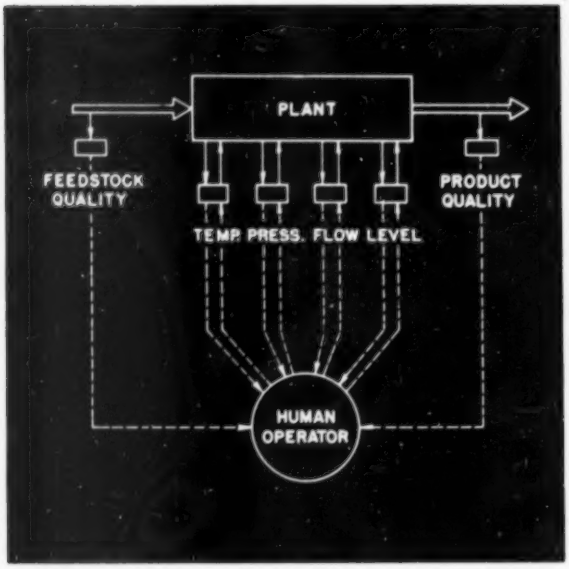
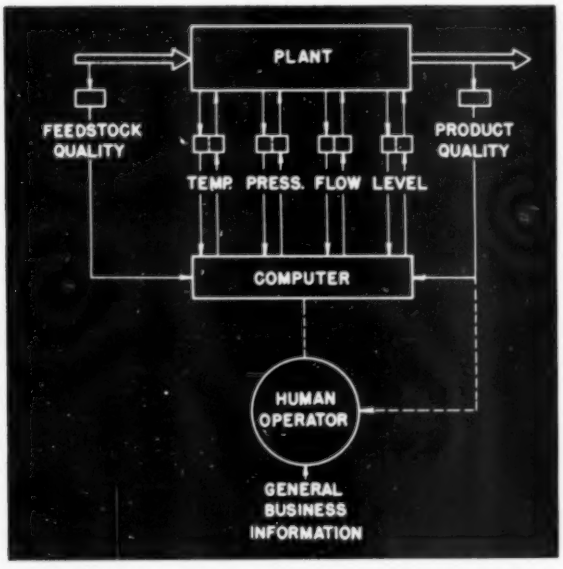
NEWS in VIEWS

3000-gal. "Drums" for asphalt. Four such containers rigged onto gondola cars, but readily transferable to ships or barges, facilitate asphalt shipments for Union Oil of California. Art Smith (left), and Harold Wilson, Rodeo refinery asphalt men, inspect one.

Hand Packed Anodes for cathodic protection of tank bottoms and underground piping at Shell Oil Co.'s Dominguez, Calif., refinery. Company manufactures its own by filling containers with coke on this special scaffold. A total of 59 tanks are now covered by these anodes.



TODAY—automatic control of process variables plus human monitoring to reflect effects of feed and product quality



TOMORROW?—automatic control of process variables and feed and product quality by computer plus some human monitoring

ONE APPROACH TO

Automatic Process Control

Last month two petroleum company engineers presented an extremely clear definition of the automatic factory problem and how it may eventually be solved. They said that:

1—Automatic control has been established now as an essential part of today's chemical and petroleum plants by physical and economic requirements.

2—But practical engineering difficulties, manpower problems, and—about all—the question of economic feasibility point to a compromise between fully automatic and manually assisted control as the goal toward which the industry will be working in the next few years.

3—For a better understanding of the design of process control systems, two approaches have been tried: a) analyzing a specific operation, such as a catalytic reaction, and b) field testing, for example, of a turbine speed control system. Both present some difficulties and some advantages.

4—A new approach called correlation analysis might eliminate some of the problems of the other two. It would evaluate the dynamic characteristics of a process from the records of normal operation. It would eliminate the need of interfering with normal plant operation or waiting for a shutdown to run tests. Further, it would provide data more intimately related to actual process variable fluctuations. It could be accomplished by using modern high-speed calculation devices and techniques.

5—Computer control will very likely soon enter the picture of the automatic factory. But it will be as an aid, rather than as a substitute for, the human operator.

The following article is a condensation from the paper: "Approaching the Control Problem for the Automatic Chemical or Petroleum Plant," presented by M. V. Long and E. G. Holzmann, Shell Development Co., Emeryville, Calif., at the annual meeting of the American Society of Mechanical Engineers, New York, Dec. 1, 1952.

IN DISCUSSING the subject of automatic control and the automatic plant, emphasis has been placed on the dynamics and stability of control systems.

But just as in flying an airplane it is necessary—but not sufficient—that the pilot have complete control over the air speed and direction of his aircraft; so in plant control, too, it is not enough to tie each process variable into a dynamically stable and tight loop under the command of some reference or set point.

Good flying requires navigation, and navigation is based on information external to the aircraft under control. In the process plant of today, human operators perform the functions of pilot and navigator. But faster aircraft and faster processes alike strain and eventually outrun the ability of the human brain to react and to initiate corrective action when changing conditions necessitate such action.

The modern auto-pilot is the answer of the aircraft industry to this problem. Many engineers in the petroleum industry are convinced that a parallel development in process control will, before long, lead to the computer-controlled chemical and petroleum plant.

Perhaps it is well to consider first the simpler type of control employed almost universally in today's process plants. The drawing at the left above

is a simplified diagrammatic representation of a typical automatically controlled plant.

The fundamental process variables are closely tied to their respective set points by the use of controllers, each operating in a separate and more or less independent control loop. The coordination of all variable settings is entirely in the hands of the operator. It is left for him to determine the optimum values of these variables in accordance with available feedstock qualities and quantities in order to satisfy the requirements of product quality specification and economical production.

The problem is much more complex than it may at first appear because of the great number of variables and frequently conflicting requirements. The solution inevitably becomes a compromise based on the experience of the operator or his staff.

The primary function of the computer in the plant shown in the drawing at the right is to collect all the available plant operating data, to substitute them in physical and chemical equations, and to solve these equations in accordance with predetermined performace criteria.

A computing controller as here visualized may be expected to function continuously. It would automatically and promptly readjust control point settings of process variables whenever the load or other conditions warranted. Thus the plant would continue to operate under conditions which today, without the aid of such a computer may lead to off-specification product or possibly plant shutdown. When process variables tend to exceed normal operating limits, the computer would actuate a warning to direct the operator in the steps he must take to correct the conditions. The computer would also be programmed to shut down the plant in a safe manner in the event of an emergency.

Large modern computers are so fast by comparison with most chemical and refining processes that a computing controller may quite conceivably be capable of taking on more than the task of over-all coordination of process variables. By making use of sub-routines in the computer to carry out the functions of proportional, reset, and rate actions, many if not all of the conventional controllers may be eliminated.

Attractive as this picture of the future plant may be, there are formidable obstacles yet to be overcome before it is likely to become a reality in the chemical and petroleum industries. One is the question of reliability of equipment. Much development work will have to be shouldered by equipment manufacturers and users alike to bring us near the goal of possible 10 or 15,000 hrs. of continuous operation without interruption due to equipment failures.

Closely interwoven with that question are the problems of maintenance staff. It is certain that new, specialized skills will be required for maintenance. Serious problems will be involved in acquiring and training men for the highly skilled jobs that will have to be filled. Not only will these maintenance engineers need a basic understanding of the processes, but also they must be thoroughly familiar with the new computing techniques.

In the processing plant of today human operators are no less essential than control systems. Each makes an indispensable contribution toward economical production. It is the conviction of the authors that this will continue to be the case in the foreseeable future.

Time and again control systems which looked very attractive in the design stage have failed to come up to expectation after installation. The efforts of the process and control engineer alike are therefore directed not so much toward extension of automatic control as to the improvement of over-all plant operation and operability, bearing in mind the close balance between economic advantages to be gained and the cost of research and application of equipment to achieve these results.

Two approaches are being taken by the chemical and petroleum industries to implement an extensive program of study to improve process control for the ultimate advancement of their economic position.

First: more fundamental and basic considerations of system dynamics are being carried out in the early stages of process development and pilot plant operation. Known as operational analysis, this route will extend the knowledge of process kinetics and system dynamics and supply basic information for future plant design.

Second: field and laboratory tests on operating plant units and control instruments are being conducted to obtain static and dynamic data on processes and specific control elements of interest.

Both methods are being employed in a program now underway at Shell Development Co.

Operational Analysis

The application of feedback principles in plant control was practiced years before any comprehensive theory concerning closed loop systems had been developed. The term "automatic control" was used to describe such systems, emphasizing one of the advantages over manual control, namely the removal of the need for continually checking and readjustment of each process variable.

A revolution in thinking was precipitated with the recognition of the basic similarity between problems in automatic control and those in the field of communication engineering, where very powerful mathematical tools had already been developed. With the help of these analytical techniques, an entirely new approach was made to study and describe the behavior of automatic systems.

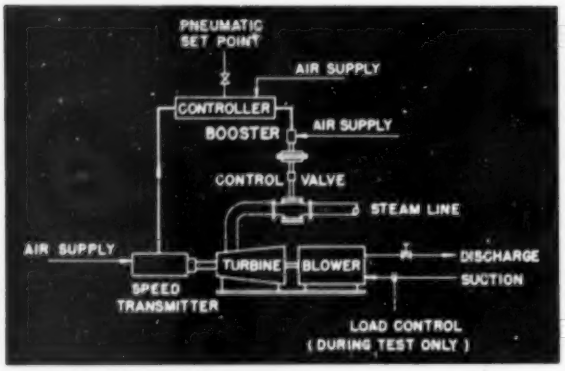
These developments in the theory of control received impetus under the war-time urgency for highly accurate remote position control systems in military applications—anti-aircraft guns, and the like. When the veil of secrecy was lifted, it appeared that the work done on military servomechanisms opened up great new possibilities in the field of control engineering generally.

A number of reasons account for the fact that even now, almost eight years after the end of the war, we are still only beginning to realize the full potential benefits of this new branch of engineering science, which has been appropriately called "system engineering."

One reason is that during the past two or three decades the art of control has tended to gravitate toward a set pattern of thinking based on an empirical approach. Novel designs were developed by cut-and-try methods. It was hopefully assumed that the built-in flexibility and rangeability of the instruments would compensate for any lack of accuracy in the design of the control system. The plant operating staff was expected to achieve stable and satisfactory, though not necessarily most efficient or most economical, operation by subsequent adjustments on the completed plant.

This method of approach was reasonably successful, while a number of pioneering attempts to base the design of control systems on known mathematical relationships had proved inadequate. Consequently, it was no easy matter to move away from the established pattern of thinking and to engender enthusiasm for a new and different approach.

The new approach is based on theoretical concepts. Like all theory, it makes certain simplifying assumptions and then proceeds to deal as rigorously as possible with the simplified problem. The solution is found with mathematical certainty, and its



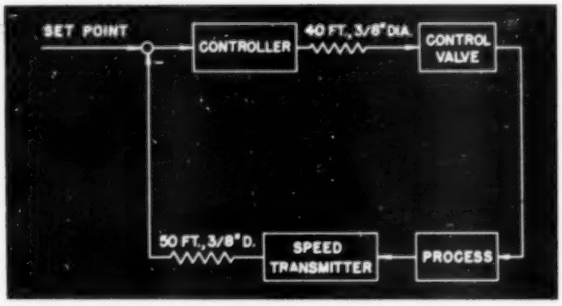


FIG. 1—(left) Layout of speed control system for turbine

FIG. 2—Block diagram of the turbine speed control system

accuracy is as good as the assumptions that were made in formulating the problem.

The method of operational analysis, or frequency response analysis as it is sometimes termed, is mathematically rigorous. The techniques can, however, be used without reference to the rather advanced mathematical concepts on which they rest by any engineer who devotes to their study the same amount of time and effort that he would give to any branch of his broad field which he considered of sufficient interest.

At this point the paper enters a detailed account—with a mathematical treatment beyond the scope of this article—of the practical application of operational analysis to the control of temperature in a continuous catalytic reaction process.

The process is an exothermic reaction occurring in a number of parallel, vertical tubes, with reactants entering at the top and the product stream emerging at the bottom. The high reaction temperature is controlled indirectly by regulating the temperature of the liquid coolant which circulates around the tubes. The heat of reaction keeps the coolant at its boiling point, corresponding to the pressure maintained in the outgoing vapor line. The control loop is closed by a pressure controller which actuates the vapor flow control valve to keep the coolant temperature at the desired value. Vaporized coolant is replaced by inflow of liquid coolant from a condenser.

The mathematical technique sets up two independent equations for obtaining values for the two dependent variables—reaction and coolant temperatures—as a function of time or frequency. The equations chosen for the analysis express the energy balance of the coolant in the reactor and the energy balance in a single reactor tube. They represent what is known about the dynamic behavior of the process. One of the objects of the analysis is to determine suitable controller characteristics to match the dynamics of the process.

On the basis of frequency response diagrams thus developed it is possible to learn the control instrument requirements for stable operation. These results in turn were checked with an electronic analog computer. It was found, however, that some numerical discrepancy between results occurred. In view of the limited objective of the original analysis, no attempts have been made to ascertain the reasons for the discrepancy.

Test Procedures

An essential prerequisite for analyses such as that just briefly described is that reliable data be available of the dynamic characteristics of the individual elements in the control loop. Recognizing this need, Shell has instituted a large scale program to obtain experimental data on the dynamic characteristics of controllers, transmitters, valves, and processes. Equipment has been assembled both for laboratory and field testing, and the facilities are being expanded as the scope of the program increases.

One typical set of field tests was on a pneumatic speed control system installed at one refinery last year. The controlled process is a turbine and blower, as illustrated in Fig. 1. In the tests, discharged air passes through a valve and muffler into atmosphere, the valve serving to simulate different load conditions. The load is measured by the pressure drop across an orifice plate in the suction line. A pneumatic speed transmitter with suppressed range gives a signal proportional to the turbine speed. The output air pressure of the transmitter is fed back to a controller having proportional plus reset action.

Any deviation from the set point air pressure causes the controller to initiate a corrective action in the form of a change in the controller output air pressure. The controller output is relayed via a volume booster to a diaphragm motor steam control valve. The valve controls the steam flow to the turbine, and thus closes the control loop.

The speed measurement, that is the transmitter output, is continuously recorded in the control room.

The tests had two broad objectives. The first was to determine the best possible adjustments of the controller functions to produce stable control with minimum speed deviations during load changes and plant upsets. The second was, as already indicated, to obtain data that would permit the system to be analyzed critically from the point of view of its frequency response.

The first objective was attained by a series of tests on the closed loop, with the system operating on automatic control. The test disturbances were introduced by step changes of the controller set point. System response times were of the order of 5 seconds on light load, 10 sec. on heavy load. The response was dependent not only on the load, but also on the level of speed from which the set point was changed and on the direction of the change. After numerous runs it was concluded that optimum control was achieved with a reset rate of 12 repeats per minute (0.2 repeats/sec.) and a proportional band setting of 90%.

Frequency response tests were not made on the closed loop nor even on the entire open loop, but only on sections of the system. Fig. 2 is a block diagram of the speed control system with open loop broken down into three sections corresponding to the actual tests.

The results are shown in Figs. 3 and 4. The amplitude ratio curve for the controller has a slope of —1 at low frequencies, due to the integrating action. The knee in the curve at a frequency of 0.2 radian/sec. is directly related to the reset rate and equal to it. The controller response falls off sharply above 5 radians/sec.

The control valve and actuator mechanism have a breakpoint at about 0.25 radian/sec. The response includes the effects of the volume booster and of the connecting tubing

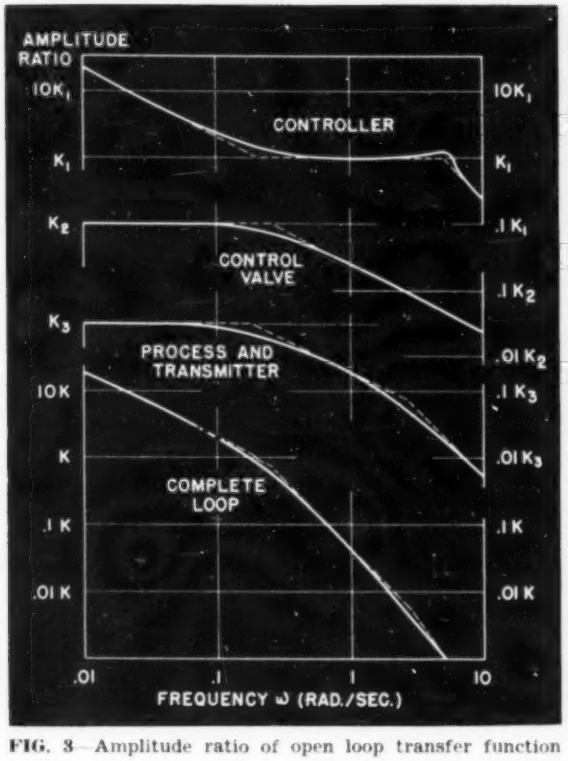


FIG. 3—Amplitude ratio of open loop transfer function

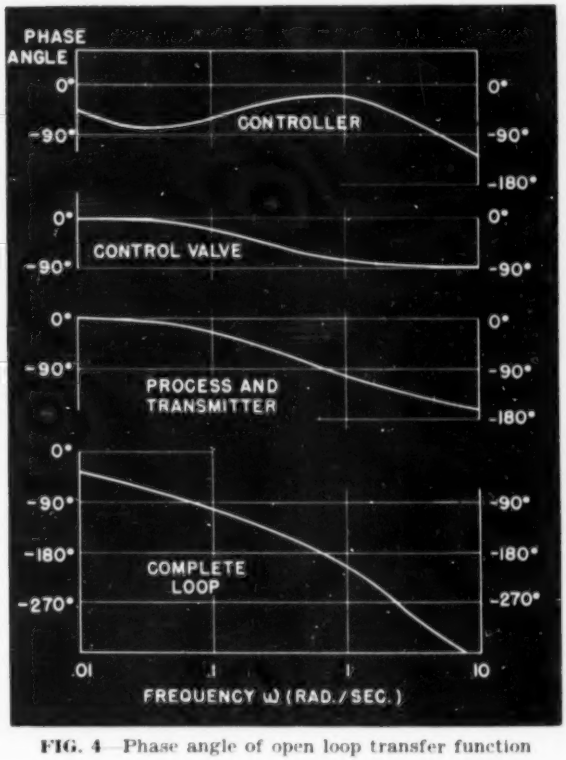


FIG. 4—Phase angle of open loop transfer function

between the controller and the valve. The transfer function of the turbine and transmitter, with the pneumatic tubing to the controller, has two first-order breakpoints. One occurs at about 0.2, the other at 2.5 radian/sec.

The bottom curve in Fig. 3 represents the composite amplitude response of the three sections when placed in series around the loop. It is derived by graphical addition of the three experimental curves above it. Fig. 4 shows the phase angle response curve of the loop, derived in the same manner.

A comparatively simple mechanical system is presented in these data. The time taken to run the tests was about 500 man-hrs., not including the work required in evaluating the results.

The practical difficulty of obtaining the complete open loop response by a single frequency response run is evident, considering that the relevant breakpoints are spread over a range of frequencies of about 50 to 1. The system gain in the same range of frequencies changes by a factor of approximately 1000.

Since the signal amplitude in a low-pressure pneumatic system is strictly limited if serious nonlinearities are to be avoided, it is readily appreciated that coulomb friction and noise effects make it impossible to obtain reasonably accurate data over so large a range of amplitude ratios. Another very serious difficulty is that when a closed control loop is opened for the purpose of response tests, the operating level usually cannot be held steady and tends to drift away from the control point of the closed loop

Correlation Method

A different approach would evaluate the dynamic characteristics of a process from records of normal operation. Such a procedure first of all eliminates the necessity of interfering with normal plant operation or waiting for a shutdown to run tests. Secondly, dynamic data so obtained would be more intimately related to the fluctuations of process variables under actual operating conditions. The results would include not only operational transfer functions between points of measurement, but also a statistical picture of the nature of the signals passing those points in the control loop.

Two main reasons account for the fact that an approach of this type has not yet been adopted in practice. One is that the statistical nature of the information requires the processing of a very large quantity of data if the results are to be reliable. Done by hand, such processing is obviously time-consuming and expensive.

The other difficulty is that the method can be applied with success only if accurately synchronized recording instruments are employed for all the variables to be correlated. In seeking to establish the number of minutes taken by a transient in passing through medium-sized heat exchangers, one would hardly trust input and output records obtained on conventional 24-hr. charts, mounted on conventional recorders in the conventional manner.

It is evident that some form of computing equipment is needed for the application of correlation techniques to chemical and refinery processes. Whether the data should be processed in an analog or a digital computer is a question whose answer would depend primarily on the availability and cost of equipment, including suitable multi-channel or otherwise synchronized recorders. Shell is currently considering the possibilities of utilizing facilities of its numerical analysis laboratory and, in particular, its IBM Card Programmed Calculator for these computations.

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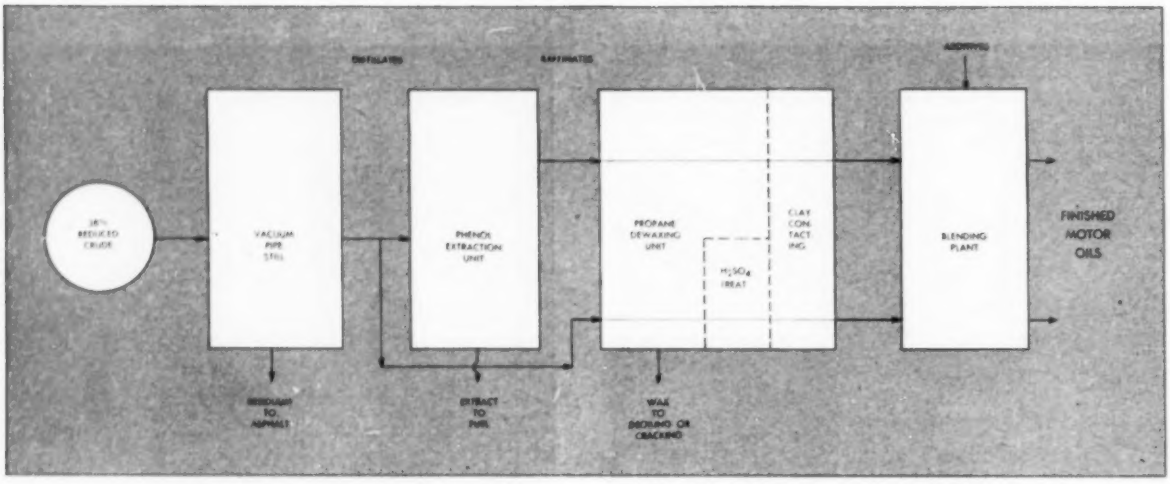


FIG. 1—General flow diagram of Indiana Standard's new motor-oil facilities at Whiting

Modernized Motor Oil Facilities

Indiana Standard extends solvent extraction, acid treatment methods at revamped Whiting refinery

By H. F. NOLTING and R. B. SELUND
Standard Oil Co. (Indiana)

NEW facilities for the manufacture of motor oils are now in full operation at the Whiting refinery of the Standard Oil Co. (Ind.). Reduced Mid-Continent sweet crude is the charge stock used to manufacture the motor oils by the operations shown in Fig. 1. Premium motor oils are made by solvent extraction, and other grades are made by acid treating in propane solution. Although the units are designed to manufacture about 2,000 B/SD of finished motor

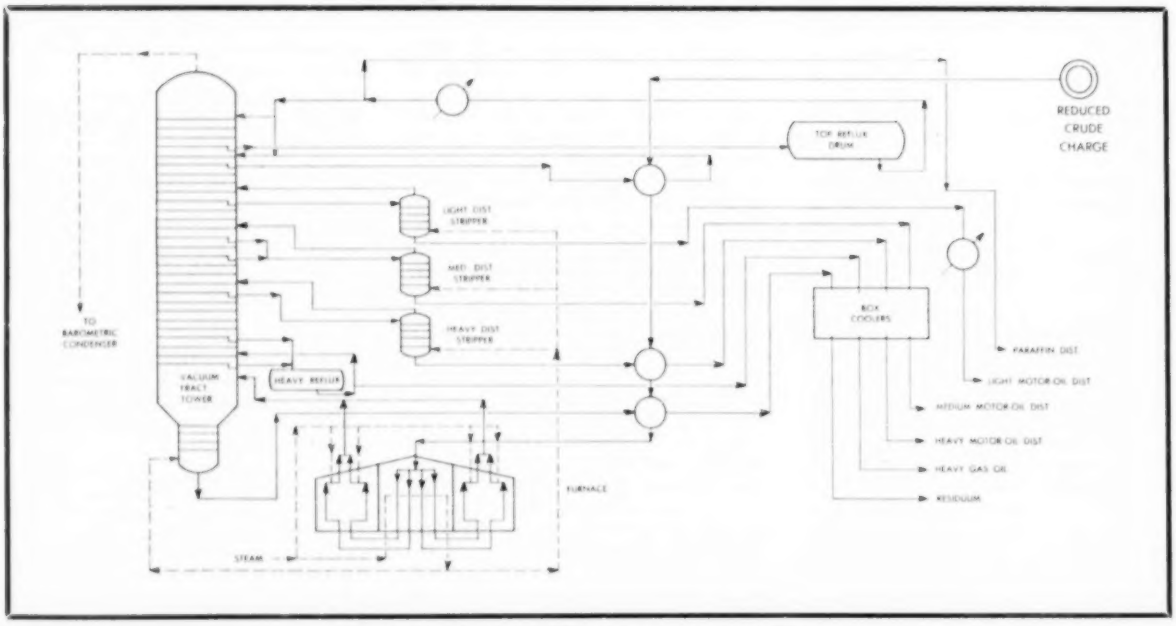


FIG. 2—Vacuum Distillation unit flow diagram

oil, the propane dewaxing unit in particular operates well above the design rate.

The discussion that follows gives a brief description of the performance of the individual units.

Vacuum Distillation Unit

The vacuum distillation unit is shown in the accompanying photograph. In the foreground are the exchangers and condensers. Pump and control rooms are located in the building below the exchangers. The furnace is at the right, and in the background is the vacuum fractionating tower.

A simplified flow sheet of the unit is shown in Fig. 2. Reduced crude from an atmospheric distillation unit is preheated in the exchanger system against hot products streams and then heated in the pipe-still furnace to about 750° F. Steam is added to the reduced crude in the furnace. The steam passes to the vacuum tower, where about two-thirds of the charge is vaporized at an absolute pressure of about 100 mm. of mercury.

The residuum is steam stripped in the bottom four trays, while the vapors are fractionated into three motor-oil distillate side streams and an overhead stream which is a light paraffin distillate. Liquid drawn from the 27th tray is cooled and returned to the 28th tray, which is the top of the tower as far as fractionation is concerned. The 29th tray is a total-trapout tray, and this and the top three trays serve as a total condenser for the oil vapors.

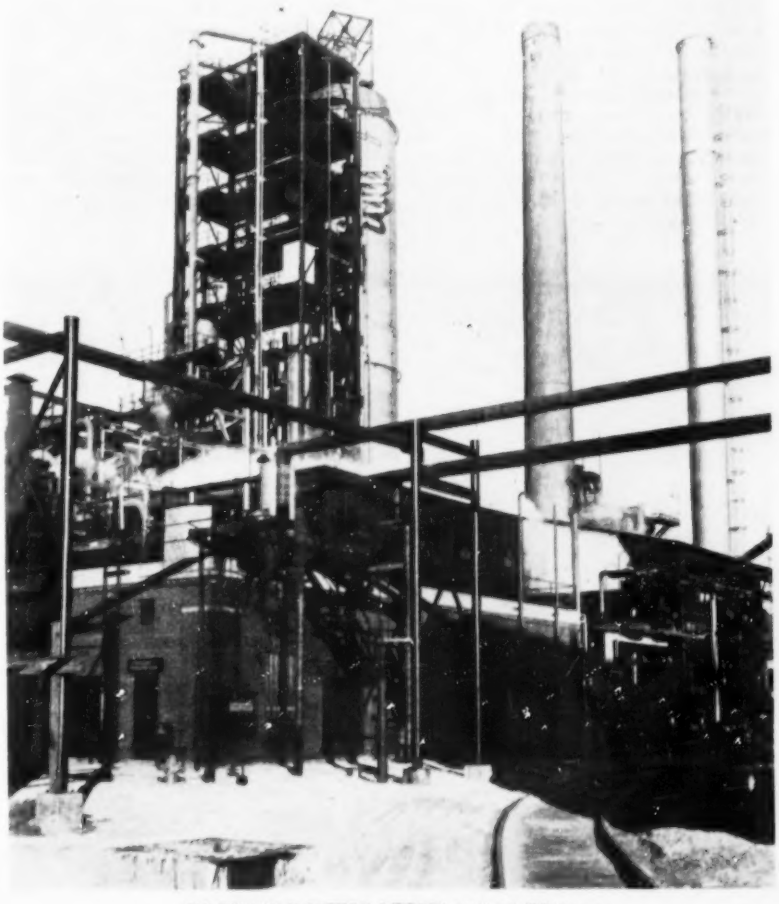
The reflux serving the condensing trays is partially diverted to the 28th tray where, under instrument control, it augments the normal reflux to the distillation portion of the tower to obtain proper temperature control. Only the steam and a trace of oil pass overhead from the tower to the barometric condenser, which condenses the steam and creates the required vacuum. Two sets of steam ejectors aid in maintaining the vacuum. Three small towers, set one above another to make a continuous tower, are used for steam stripping the motor-oil distillates to remove light ends and obtain specification flash point.

The vacuum still may be operated for the simultaneous production to specifications of three motor-oil distillates and a residuum. Typical performance of the unit when producing light, medium, and heavy distillates is illustrated by the data in Table 1. It will be noted that the fractionation efficiency of the tower is high, since the distillates are light in color, high in flash, and show little overlap in distillation range.

Alternate operations give automatic-transmission-fluid distillate in place of light motor-oil distillate and

Table 1—Performance of Vacuum Pipe Still

Reduced-Crude Charge, B/SD		11,600
Fuel Consumption		1.90% of charge
Utilities:		
Electric Power, KW		107
90 psig Steam, lbs./hr.		25,250
75° Water, GPM		4,140
Product Quality		
Light Distillate		
Viscosity, SSU at 100° F.		171
Flash, ° F.		410
Color, NPA		2½-3
Conradson Carbon		0
Distillation, 1 mm. Hg.	5%, ° F.	389
	50%, ° F.	414
	90%, ° F.	456
Medium Distillate		
Viscosity, SSU at 210° F.		60.6
Flash, ° F.		475
Color, NPA		5
Conradson Carbon		0.20
Distillation, 1 mm. Hg.	5%, ° F.	468
	50%, ° F.	491
	90%, ° F.	533
Heavy Distillate		
Viscosity, SSU at 210° F.		101
Flash, ° F.		545
Color, NPA		3-4½ (dil.)
Conradson Carbon		0.80
Distillation, 1 mm. Hg.	5%, ° F.	531
	50%, ° F.	570
	90%, ° F.	612
Residuum		
Softening Point, ° F.		92
Flash, ° F.		655
Spot Test		Negative



VACUUM DISTILLATION unit at Whiting

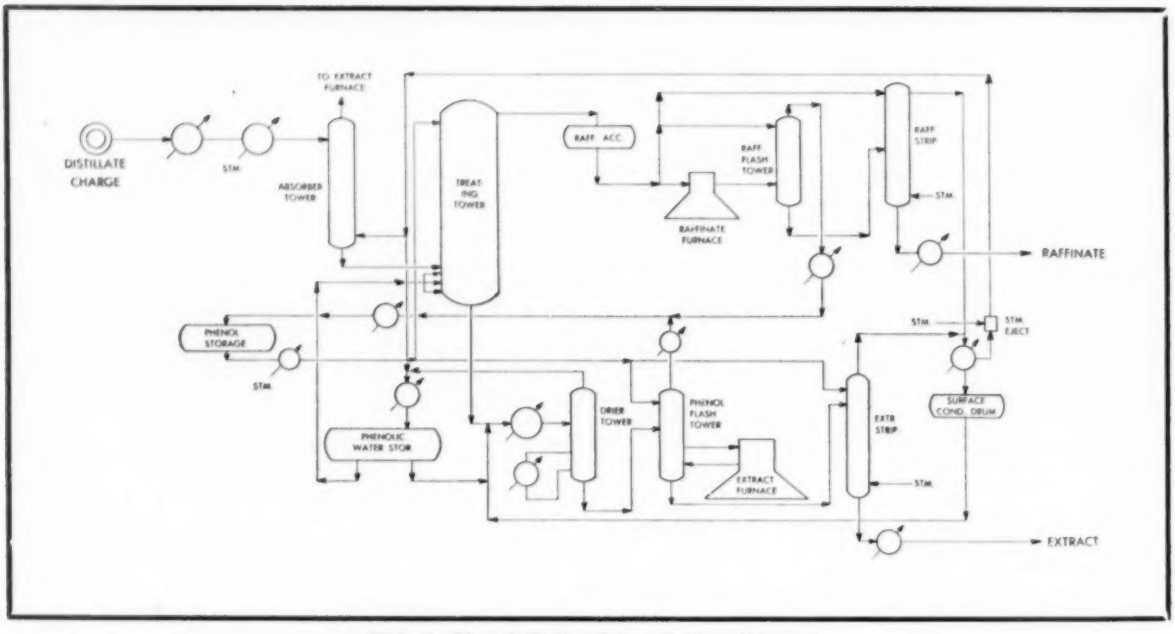


FIG. 3—Phenol Extraction unit flow diagram

a wide cut of heavy paraffin distillate in place of light and medium motor-oil distillates.

Phenol Extraction Unit

The phenol extraction unit treats the distillate produced on the vacuum pipe still in order to remove the unstable components of low viscosity index. The above photograph shows the treating and phenol-recovery towers. In addition there are two A-frame furnaces which provide heat for phenol removal from the extract and raffinate solution. A simplified flow sheet of the operation is shown in Fig. 3. After the charge oil is used to absorb phenol from a vapor stream, it is introduced into the lower part of a liquid-phase treating tower, which contains 20 trays, for contacting the oil and phenol.

Phenol is introduced above the top tray and flows downward through the tower, while the oil, of lower specific gravity, rises through the tower from its point of entrance five trays above the bottom. Water containing

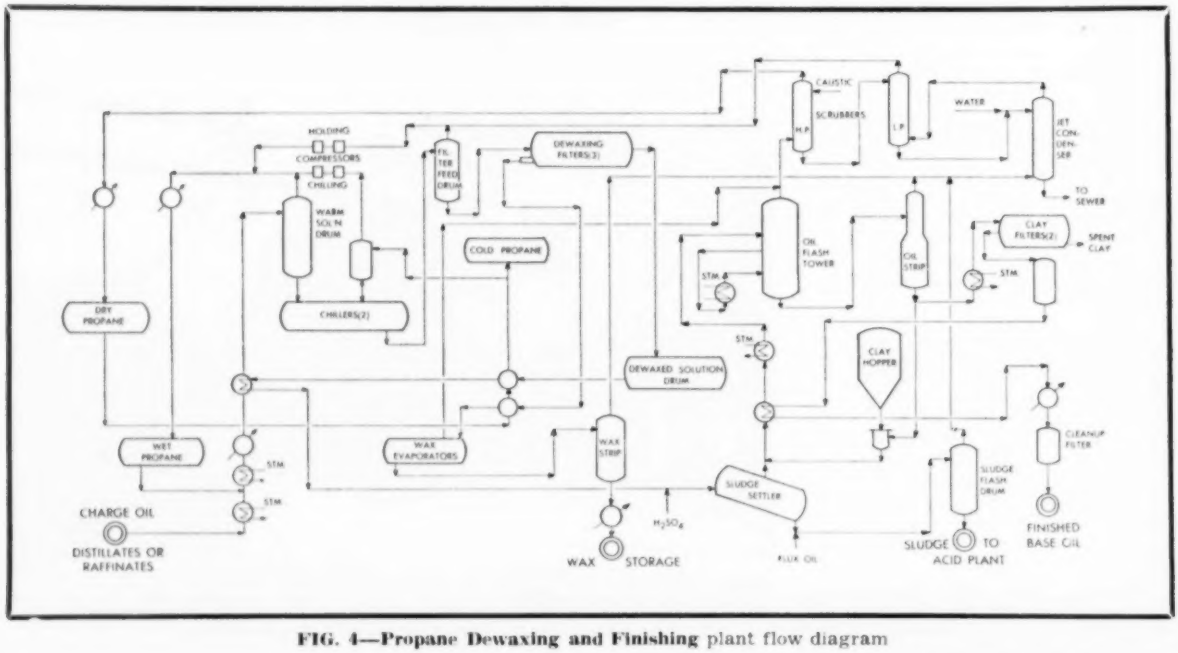


FIG. 4—Propane Dewaxing and Finishing plant flow diagram

some phenol is introduced into the tower below the oil feed to give improved treating yields. The bulk of the total phenol containing the water and extracted oil is drawn off from the bottom of the tower, and the water is distilled off in the drier tower. The dry extract solution is heated in a furnace, and the phenol is removed in the recovery system.

The highly aromatic extract is used chiefly as refinery fuel. The treated oil, or raffinate, in which some phenol is dissolved, is heated in a furnace and sent to the recovery system where the phenol is removed. The phenol from all sources is condensed and recycled with a loss of about .004% per cycle.

The unit is designed to run at phenol-to-oil ratios of from 1:1 to 3:1 depending upon the viscosity-index improvement desired. Oil charge rates range from 2,250 B/SD to 4,700 B/SD, with a maximum design phenol-circulation rate of 6,700 S/BD. Table 2 gives typical performance and inspection data for heavy-distillate operation.

Essentially all operations have been run with the temperature at the top of the treating tower 15° to 20° F. higher than at the bottom. Data taken over short periods of time, when isothermal conditions were maintained in the tower, indicated no significant change in the performance of the tower.

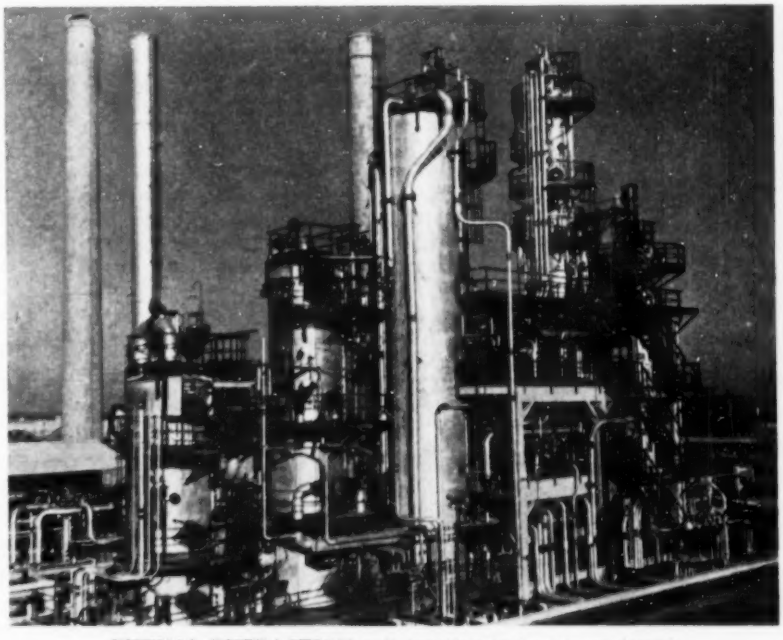
Comparison of the tower results with laboratory countercurrent batch extraction indicates that the tower operation is equivalent to about five theoretical stages. Best operations are obtained when maximum phenolic water is added about equally at three points provided below the oil-feed inlet. It has been found essential to maintain the interface at or above the middle of the tower. Under these conditions, expected yields and product quality are obtained.

After about six months of operation, the unit was shut down for inspection and repairs. The only serious corrosion was found in the carbon-steel tubes and headers of the extract furnace, where velocities are high and the phenol concentration is on the order of 75-80%.

Propane Dewaxing and Finishing Plant

The propane dewaxing and finishing plant performs three separate functions: dewaxing, acid treating, and clay contacting. The general layout of the plant includes a pump house and control room, heat-exchanger and propane-recovery system, and clay-contacting equipment. A large building to the rear of the unit houses the compressors on the first floor and the wax filters on the second floor.

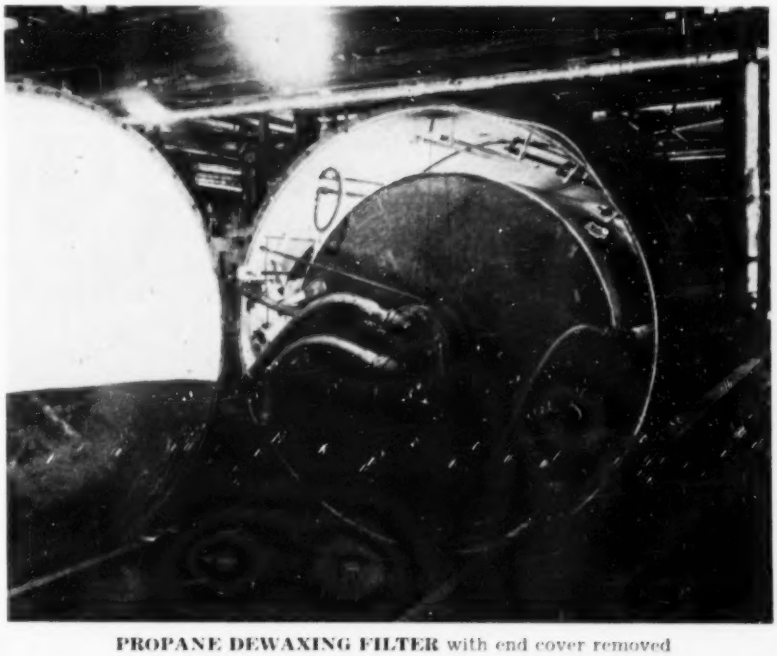
A simplified flow sheet of the dewaxing operations is shown in Fig. 4. The feed stock is dried and mixed with a wax-crystal modifier by heating and blowing with air in the charge tank. The oil is then mixed with propane and heated in an exchanger system to destroy all previously formed wax crystals. Partial cooling of the oil-propane mixture is obtained by exchange with cold dewaxed solution, following which the mix is introduced into a tank chiller.



PHENOL EXTRACTION unit treating and recovery towers

Chilling is accomplished by evaporation of propane until the desired filtering temperature of −44° F. is reached. Propane serves both as a diluent and as a refrigerant in this process, and cold liquid propane is added during the chilling operation to maintain the desired ratio of propane to oil for efficient filtration. The chilling period is approximately twenty minutes per batch.

While one batch is being chilled, the previous batch of chilled solu-



PROPANE DEWAXING FILTER with end cover removed

Table 2—Performance of Phenol Extraction Unit
Heavy-Distillate Operation

Distillate Charge, B/SD	2,320
Phenol Circulated, B/SD	6,720
Raffinate Produced, B/SD	1,340
Entrained Oil in Extract Solution, %	2.5
Entrained Phenol in Raffinate Solution, %	2.8
Fuel Oil Consumed, Vol. % on Charge	7.3
Utilities:	
Electric Power, KW	275
100 psig Steam, lbs./hr.	2,500
85° F. Water, GPM	1,545

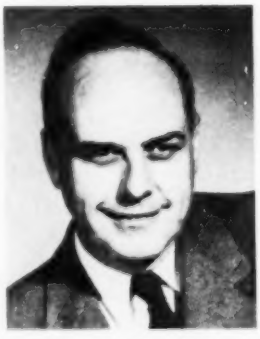
Inspections	Charge	Raffinate	Extract
Viscosity, SSU at 210° F.	145	92.1	459
Flash, °F.	555	565	545
Pour Point, °F.	95	120	70
Refractive Index, n_D^{20}	1.5026	1.4759	1.5400
Phenol Content, %	0	.0005	.0015

Table 3—Performance of Propane Dewaxing Unit
Light-Raffinate Operation

Oil Charge, B/SD	3,120
Propane Charge, B/SD	5,420
Wax Modifier, B/SD	28.5
Utilities:	
Electric Power, KW	1,307
100 psig steam, lbs./hr.	20,575
400 psig steam, lbs./hr.	5,387
15 psig steam, lbs./hr.	2,045
75° F. Water, GPM	1,742
Product Quality:	
Dewaxed Oil:	
Viscosity, SSU at 100° F.	92.0
Viscosity, SSU at 210° F.	44.2
Viscosity Index	96.8
Pour Point, °F.	0
Flash, °F.	400
Color, NPA	1½-2
Wax:	
Oil Content, %	18.4
Melting Point, °F.	127.5

Meet the Authors

Mr. Nolting



Mr. Selund

Henry F. Nolting has been with Standard Oil Co. (Ind.) for 11 years and is now general foreman of the Wax Department. He obtained his M. S. degree in chemical engineering from Purdue University in 1939, and was thereafter affiliated with Ashland Oil and Refining Co. and Hercules Powder Co. before joining Indiana Standard. He is a member of the American Institute of Chemical Engineers and is currently treasurer of the organization.

Robert B. Selund is a section leader in the Technical Service Division of the Research Department of Standard Oil Co. (Ind.). He joined Indiana Standard following graduation from the University of Minnesota in 1930 with a B. S. degree in chemical engineering. His technical activities have been concerned with crude-oil evaluation, distillation and coking, and with the manufacture of motor oils, waxes, sulfuric acid, and sulfur. Mr. Selund is a member of American Institute of Chemical Engineers and the American Chemical Society.

tion, containing the precipitated wax, is filtered through rotary filters. The accompanying photograph shows the inside of a wax filter. Cotton twill filter cloths were originally employed, but nylon filter cloths are now being used to advantage because of improved wax-cake discharge. Cold liquid propane is sprayed on to the wax cake to reduce the oil content.

The dewaxed solution is acid treated whenever necessary. Ordinarily, only the unextracted distillates are acid treated. The advantages of acid treating in propane solution are reduced acid consumption, higher treating yields, and reduced sludge-settling time. The rapidity of sludge settling is evident when one considers that sludge is settled from the sour solution in less than 50 minutes, as compared with periods as long as 24 to 36 hours by the old batch-treating methods.

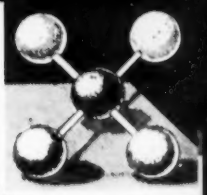
After being treated, the solution is contacted with activated clay for neutralization and improvement of color stability. Propane is then removed and the clay-oil slurry is filtered on precoat filters for removal of the clay. A temperature of about 400° F. is used in the recovery system and retention time is sufficient for effective clay contacting. The oil is cooled and pumped to the motor-oil blending plant for compounding into finished motor oils.

The design capacity of the unit is 2,510 B/SD of feed stock for light distillates and raffinates, and 2,235 B/SD for the heavy distillates, raffinates, and bright stocks. Throughputs considerably higher than design have been obtained, particularly on low-viscosity stocks. The performance of the unit on light raffinate is illustrated by the data of Table 3.

Motor Oil-Blending Plant

The oils from the propane dewaxing and finishing plant are sent to the motor-oil blending plant. Here the various motor-oil base stocks are blended with additives to produce finished motor oils. The blending is performed by machines which handle four major and two minor components. This unit compounds oil directly for tank-car or barrel shipments. No storage is available for finished motor oils, other than small tanks used in supplying canning and barreling operations in the barrel house.

The equipment is designed so that, if any meter or pump fails to deliver the proper quantity of oil, the entire blending unit automatically shuts down. Thus, once the machines are set to give a product of the desired specification, they will continue to deliver a product of this specification throughout the operation.



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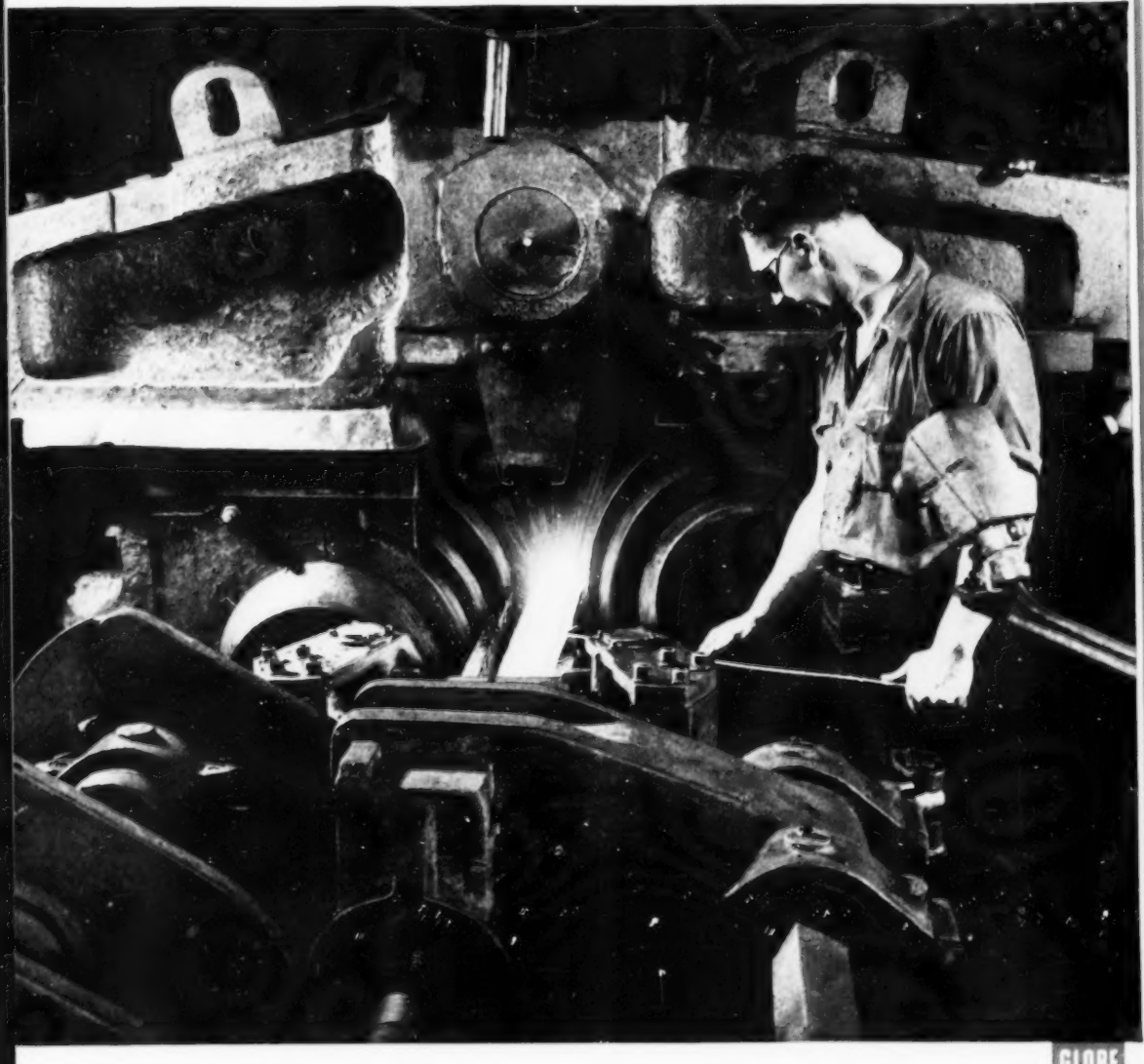

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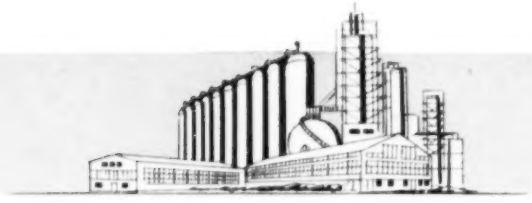

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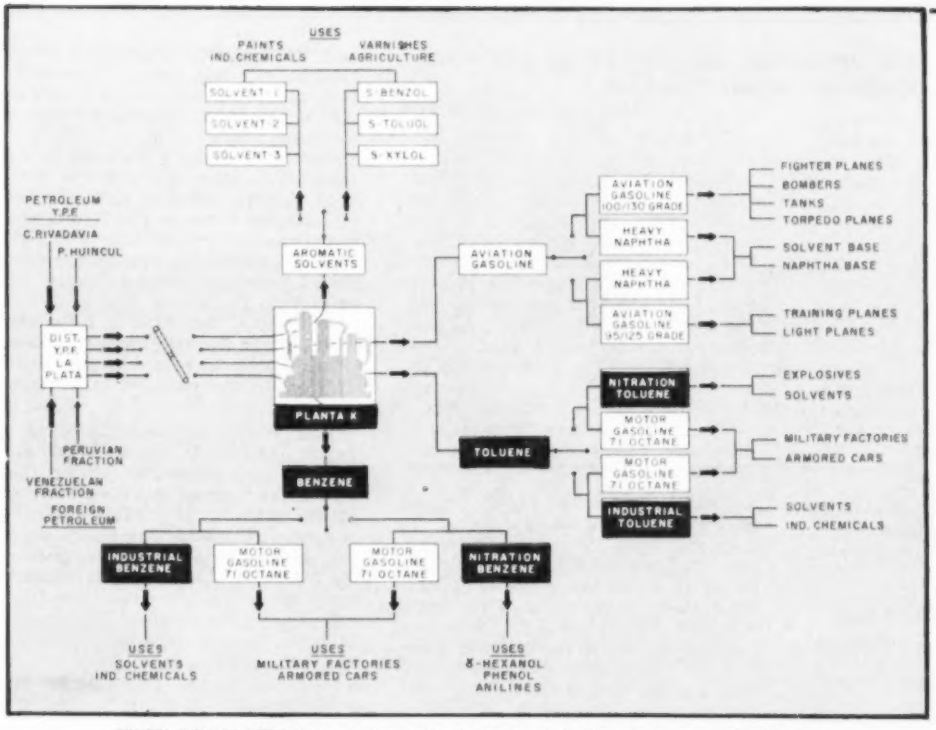


HOW AROMATICS from Argentine's new catalytic reforming unit fit into that country's industrial development activities

AROMATICS RECOVERY

By Hydroforming and Phenol Extraction

From a report by J. J. SWIFT, S. R. STILES, E. W. HOWARD and M. TARNPOLL
The M. W. Kellogg Co.

The new Hydroforming and aromatics extraction plant in Argentine was built primarily to make nitration grade toluene. Design flexibility is such, however, that it has successfully produced nitration grade benzene and finished aviation gasoline of 91/98 and 100/130 grades.

The Hydroformer of Planta K, as it is known, consists of a fixed-bed unit with two reactors, of the basic design of previous units. The aromatics recovery system for extracting pure aromatics from the Hydroformer crude concentrate uses the phenol extraction principle licensed by Shell Development Co. Design and installation of both units was by M. W. Kellogg Co. For purposes of military security, capacity figures and similar data are omitted from the accompanying description.

SUCCESSFUL operation of the Hydroforming and aromatics extraction plant recently completed for the Argentine government marks an important step in that country's far-reaching program of self-sufficiency and industrial development. The plant is the only one of its kind in the world outside the U. S.

The project was conceived and constructed by the Direccion General de Fabricaciones Militares (D.G.F.M.) primarily for making nitration grade toluene. Since the start of operations on April 26, 1951, nitration grade benzene and aviation gasoline of 91/98 and 100/130 grades have been successfully produced. The flexible operation of the plant is accelerating the industrial development program of the Argentine government in related fields. The chart above graphically illustrates the significance of Planta K, as it is known, in this respect.

Initial operation of the plant was under the control of D.G.F.M., with a staff of one process engineer and seven operating engineers provided by Kellogg Pan American Corp. acting in an advisory capacity until the completion of the performance test runs. The plant was heated up and the naphtha cut into the first reactor April 26, 1951, using a narrow-boiling C_7 naphtha fraction for production of toluene. The initial operation was primarily for training plant operating personnel and development of operating condi-

Table 1—Comparison of Design Feed and Actual Feed with Yield Guarantees for Toluene Production

	Design Feed	Actual Feed
Specific Gravity	0.742	0.7346
ASTM Distillation, ° C.		
IBP	95.0	97.6
5%	97.2	98.3
10%	97.2	98.7
20%	97.7	99.0
30%	97.7	99.2
40%	97.7	99.5
50%	97.7	99.8
60%	98.3	100.2
70%	98.3	100.7
80%	99.0	101.5
90%	99.5	102.7
95%	100.0	104.2
Dry Point	....	106.6
End Point	113.5	....
Vol.% Paraffins	39.8	55.95
Mol.% Olefines	1.4	6.73
Vol.% Aromatics	11.9	2.77
Vol.% Naphthenes	46.9	34.65
Nitration Grade Toluene Guarantee Yield, wt.%	35.0	19.3

Table 2—Characteristic Yields for Toluene Operation

	Corrected Yields (Output Basis)
Gas	11.0 Wt.%
Light Naphtha	50.5 Wt.%
Heavy Naphtha	5.0 Wt.%
Polymer	1.8 Wt.%
Nitration Grade Toluene	31.4 Wt.%
Coke	0.3 Wt.%
TOTAL	100.0 Wt.%

tions leading to test runs. Contractural guarantees were fulfilled by May 31, 1951, and the plant officially approved and accepted by D.G.F.M. The plant was completely constructed by native Argentine labor.

The plant operation has been successful from the outset, actual performance exceeding design guarantees with respect to yields, quality of products and utilities consumption. Planta K has been in continuous operation for more than a year since its initial startup except for interruptions due to power failure and a short shutdown to change the catalyst in one reactor.

Prior to the initiation of the process design, basic laboratory work was carried out in the M. W. Kellogg laboratories using narrow-boiling C_7 fractions from Comodoro Rivadavia and Challaco crude oils, which are native to Argentina. Because of local difficulties in obtaining feed stock from the Callaco crude source, a narrow-boiling range C_7 fraction from Comodoro Rivadavia crude stock only was used as feed stock for the toluene operation. The yield guarantees were revised to reflect the changed feed stock composition as compared with the design feed. Comparison of the actual feed and design feed with the corresponding yield guarantees is shown in Table 1.

Operation of the plant showed the characteristic yield for the toluene operation given in Table 2. The yield of nitration grade toluene obtained exceeded the guarantee yield for the actual stock feed. The inspections of the products resulting from the toluene operation may be exemplified by the composite average of products obtained during the test run as shown in Table 3. The quality of the toluene produced in Planta K is considerably superior to the specification requirements for nitration grade toluene. This quality is obtained at the expense of yield and it is conceded that producing toluene just meeting ASTM specifications would result in increased yield.

Table 3—Composite Average of Products Obtained During Toluene Test Run

	Raw Concentrate From Hydroformer (Feed To Extraction)	Light Naphtha	Heavy Naphtha	Toluene
Specific Gravity	0.7717	0.7104	0.9033	0.8716
ASTM Distillation, ° C.				
IBP	94.5	43.0	140.0	110.3
5%	98.0	52.0	141.5	110.4
10%	99.0	61.5	142.0	110.4
20%	100.5	76.8	143.5	110.5
30%	100.6	82.5	145.0	110.5
40%	101.3	86.2	148.0	110.6
50%	102.2	88.8	151.0	110.6
60%	102.3	91.2	158.0	110.6
70%	103.3	93.3	168.0	110.6
80%	104.6	95.5	228.5	110.6
90%	106.9	98.4	260.0	110.6
95%	108.8	102.3	278.5	110.6
Dry Point	114.3	104.0	....	110.8
End Point	....	....	300.0	....
Vol. % Olefines	4.8	8.6	....	....
Vol. % Aromatics	47.2	14.4	....	100.0
Vol. % Paraffins	48.0	77.0	....	....
Vol. % Kattwinkel	....	....	100.0	....
Octane No.-CFRM	....	60	....	....
Octane No.-CFRR	....	65	80-90	....

The light naphtha produced in the toluene operation is a mixture of the light naphtha obtained from the first fractionator tower of the Hydroformer recovery system and the light naphtha from the overhead of the phenol recovery tower following the extractive distillation. The quality of this naphtha, therefore, is a function primarily of the efficiency of the extraction process, since any unextracted aromatic will be found in this light naphtha.

This product is being used as a motor gasoline by the D.G.F.M. and shows a lead susceptibility such that the octane number is raised from 60 CFRM-clear to 81 CFRM with 3.0 cc's tetraethyl lead. The heavy naphtha, which is a polymer product from the bottom of the second fractionator tower above the aromatic concentrate cut, is rich in xylenes. This heavy naphtha product, because of its rich aromatic content, is in part sold to a refinery where it is used for solvent production, while some is rerun to gasoline end point which, because of its high octane value, is blended directly into motor gasoline production.

The toluene operation settled out smoothly in a 40-hr. total reactor cycle time, in which the breakdown of functional times are as shown in Table 4.

Following approximately 3 months in toluene operation, the unit in continuous stream was switched by change of operating conditions to a benzene operation using a narrow-boiling range C_6 fraction derived from Comodoro Rivadavia crude oil. There was available a supply of the C_6 feed stock for only 6 days' operation, so this interim operation was considered merely an exploratory run to establish desirable operating conditions for production of benzene. The feed stock in general had the characteristics shown in Table 5. This distillation range includes whatever content in the crude there may be of cyclohexane and methylcyclopentane. The cyclohexane is the preferred feed stock for conventional Hydroforming equipment, while methylcyclopentane is a less desirable component of a C_6 charge stock for benzene production. The exporatory benzene run yielded a nitration grade benzene of superior quality to ASTM specifications.

Upon completion of the interim benzene operation, attention was directed to the possibility of producing 100/130 grade aviation gasoline from Planta K, the local situation at that time dictating the need for a native production of this grade aviation product. The gasoline was produced directly from the fractionation section of the plant by selective blending of the light naphtha and aromatic base

Table 4—Breakdown of Functional Times for Toluene Operation

Reaction	20 hrs.
Recycle Gas Purge	15 min.
Depressure	15 min.
Coke burning	16 hrs. 30 min.
Reheat	1 hr. 30 min.
Catalyst pretreat	1 hr.
Repressure	30 min.
TOTAL	40 hrs.

Table 5—Characteristics of C_6 Feed Stock for the Interim Benzene Operation

Specific Gravity	0.7015
ASTM Distillation, ° C.	
IBP	66.7
10%	74.0
50%	75.0
90%	80.0
End Point	82.3
Vol. % Aromatics	5.0
Vol. % Naphthenes	63.7

stock produced in individual towers, to meet the volatility specifications. Maximum concentration of TEL was used. Using the U. S. Government specifications for 100/130 grade aviation gasoline as a criterion, the finished gasoline produced by this method in Planta K has been approved as acceptable for use by the Argentine Ministry of Defense.

Hydroforming Section

Basic studies in the laboratories of the Kellogg company prior to design of the plant, confirmed the use of Kellogg Low Soda catalyst for the Hydroforming reaction. This catalyst has proved exceedingly effective in the aromatic and aviation gasoline operations and has also shown long life. The plant has been in operation practically continuously for more than a year since April 26, 1951, when it went on stream. During this period one reactor still retains its original catalyst charge; while the other reactor required a catalyst change after 8 months due to an operational emergency which caused excessive overheating of the catalyst bed.

Prior to the design of the plant, pilot plant studies on the feed stocks contemplated being used by D.G.F.M., established the operating conditions for the design of the Hydroformer as shown on Table 6. The design functional times were established as given in Table 7.

Briefly, the Hydroformer equipment consists of two reactors containing the catalyst wherein the conversion to aromatics is accomplished. Coke is deposited on the catalyst during the reaction period, thus requiring it to be periodically regenerated. The regeneration equipment consists primarily of a flue gas generator which serves as a source of the flue gas used to control the rate and temperature of the burning operation.

A predetermined concentration of hydrogen is maintained in the reaction zone by recycling a portion of the hydrogen rich gas produced by the reaction. Products of reaction are recovered into the desired fractions in the Hydroformer fractionation facilities, and the aromatic concentrate is set to intermediate storage. This crude aromatic concentrate is subsequently contacted countercurrently with phenol in a distillation tower and the aromatic portion of the concentrate is extracted in the phenol phase. Toluene, or benzene, is then removed from the phenol and is subsequently purified by acid treating, followed by caustic neutralization and rerunning to produce the finished nitration grade aromatic.

In the main, the Hydroforming unit for production of toluene or benzene from a narrow boiling fraction is essentially the same as a similar unit devoted to the production of motor gasoline from a wide boiling range naphtha stock. The major steps as incorporated in the design of this Hydroformer may be summarized briefly as:

1. Oxygen removal from the naphtha feed in the gas absorber tower.
2. Heating the naphtha charge and recycle gas to the desired reaction temperature.
3. Reacting the naphtha and recycle gas in the catalyst chamber and cooling the products of reaction.
4. Recirculating the separator gas, rich in hydrogen, as recycle gas to the reaction chamber and feeding net product gas to the absorber tower.
5. Regeneration of the spent catalyst.

Unique design features distinguish this Hydroforming plant. Because of the expected high conversion of naphthenes to aromatics and the high heat of reaction involved, a recycle stream of light naphtha containing essentially paraffins and unconverted naphthenes is recirculated from the overhead reflux drum of the phenol recovery tower to the absorber tower accumulator drum where this recycle mixes with the fresh feed to become part of the total reactor charge. This recycle, which is primarily a diluent, is in the ratio of 2 to 1 basis fresh feed, and provides a control over the reaction rate in the reactors. At the same time this recycle provides additional heat input to the reactors without the danger of overheating the fresh feed stock. The hydrogen-rich recycle gas rate of 2500 cu. ft./bbl. is based on the total reactor charge including the recycle.

Unlike other Hydroformers this unit is designed for catalyst regeneration at essentially atmospheric pressure primarily because of the low coke production and the lack of economic necessity for steam generation from hot flue gas. Inert gas is generated from light liquid fuel and air at sufficient pressure with controlled rate O_2 concentration and temperature to maintain a maximum allowable regeneration temperature of 1100° F. in the catalyst bed. By means of the newly designed water cooling provision it is possible during regeneration to control the flue gas temperature in the range of 650 to 1100° F. and with O_2 concentrations from 0-20.5 wt.%. The volumetric capacity of air and flue gas can be varied from 50% to 100% of design capacity. These operational conditions permit maximum flexibility during the regeneration and reheating periods of the complete Hydroforming cycle.

Since the design feed stock is of an unusually narrow boiling range, and the catalytic reaction for production of aromatics yields a very low percentage of coke, it is possible to design for a 48-hr. total reactor cycle time, of which the reaction time constitutes 24 hrs. With this extended cycle time the necessity of rigid time control to the minute is unimportant, thus permitting the use of hand operated cycle timers which are extremely adequate, and at the same time, considerably less expensive than the completely automatic cycle controllers.

Aromatic Recovery Section

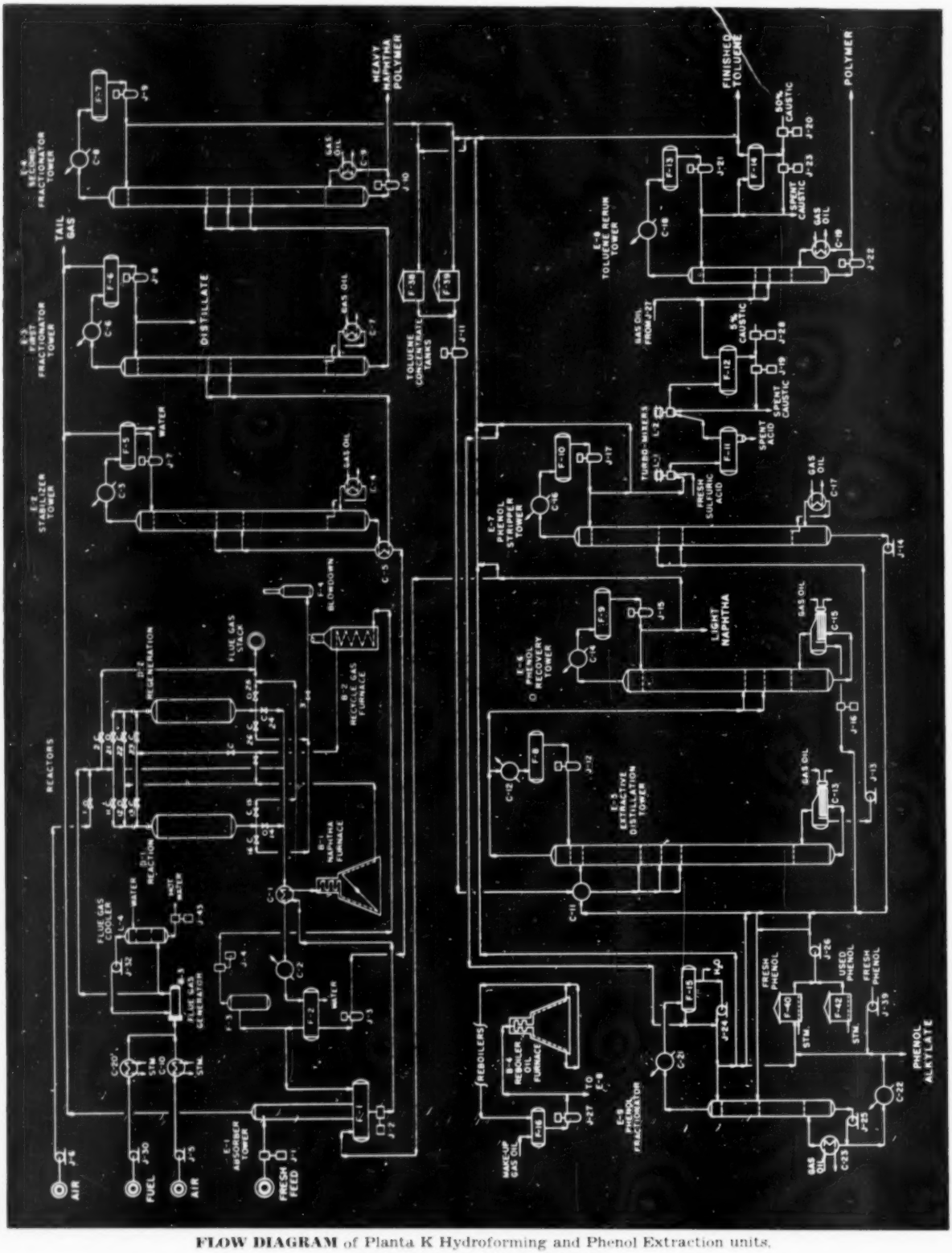
The phenol extractive distillation portion of Planta K is designed to effect a maximum recovery of nitration grade aromatics from the crude aromatic concentrate produced

Table 7—Design Functional Times for Hydroformer Operating Cycle

Reaction	24 hrs.	
Recycle Gas Purge		5 min.
Depressure		10 min.
Flue Gas Purge		5 min.
Coke Burning	18 hrs.	
Catalyst Reheat	2 hrs.	
Catalyst Pretreat	1 hr.	
Repressure		15 min.
Valve Changes		25 min.
Idle	2 hrs.	
TOTAL	48 hrs.	

Table 6—Operating Conditions for Design of Planta K Hydroforming Unit

Reaction	
Reactor Average Bed Temperature	900° F.
Reactor Average Bed Pressure	300 psig
Space velocity—V/Hr/V_c	0.75
Gas Recycle—Basis Reactor Charge	2500 cu. ft./bbl.
Liquid Recycle Ratio—Recycle/Fresh Feed	2
Hydrogen Content in Recycle Gas	69 Mol. %
Hydrogen Enrichment	None
Catalyst Regeneration	
Max. Burning Temperature	1100° F.
Circulating Flue Gas Temp. Range	650° F. to 1100° F.
Regeneration Pressure	5 psig



FLOW DIAGRAM of Planta K Hydroforming and Phenol Extraction units, as designed for toluene operation

from the Hydroforming reaction. The main process steps are:

1. Contact of the aromatic concentrate with circulating phenol in the extractive distillation tower in which the desired aromatic is removed in the phenol phase.

2. Recovery of phenol from the hydrocarbon vapor overhead of the extractive distillation tower in a separate phenol recovery tower.

3. Separation of the pure aromatic from the phenol phase in the phenol stripper tower.

4. Acid wash, caustic neutralization and rerunning, followed by drying of the finished nitration grade aromatic.

5. Phenol clean-up to recover the used phenol which ordinarily might be discarded.

The recovery of the pure aromatic by phenol is dependent upon the temperature and the ratio of circulating phenol to the aromatic concentrate charged to the extractive distillation tower. For design purposes a phenol to concentrate ratio of 6.0 to 1 was used for the toluene extraction. This ratio affords an adequate flexibility in the operation so that maximum recovery can be obtained. In operation the loss of toluene overhead from the extractive distillation tower is minimized, and the use of a separate phenol recovery tower provides a medium for effective fractionation between the unextracted hydrocarbons and the phenol carry-over from the extraction tower. The separated phenol from the bottom of this tower is returned to the extraction tower, thereby minimizing losses of phenol from the operation.

Unique features in this design contribute greatly to the efficiency of the operation. The acid treating of the pure aromatic results in the formation of a very small amount of acid polymer which is subject to thermal decomposition at elevated temperatures. Therefore, in the rerun tower, which is designed to remove any acid polymer formed, some gas oil is injected intermittently with the feed to the rerun tower to dilute the acid polymer in the tower reboiler system, thereby holding the thermal decomposition of this material to a minimum at the temperature required for the reboiling operation. Any thermal decomposition would show itself in sulfur contamination of the pure aromatic overhead of the rerun tower.

An additional feature is provided in the form of the phenol fractionator to recover contaminated phenol which ordinarily might be removed from the unit. This phenol fractionator is designed with a three-fold purpose which includes, a) cleaning out of the heavy ends from used phenol by removing phenol alkylates formed during the extraction operation, b) drying of wet phenol, c) drying of phenolic water. The phenol fractionator is so designed that it may be used in intermittent operation apart from the main extraction system, or it may be used continuously, taking its place in the extraction system sequence.

The heat medium for the many reboilers in the fractionation and extraction systems is provided by a closed circulating gas oil system with a separately fired reboiler oil furnace. This reboiler system, with controls at the individual reboilers, is designed to provide effective reboiler control, as desired, independently of the functioning of any other portion of the plant.

The utilities consumption of the plant has been lower than calculated for the design toluene operation. The approximate design utilities for the whole plant, as indicated on a per barrel naphtha fresh feed rate, are shown on Table 8.

The process description of Planta K, as represented in the accompanying flow diagram for the design toluene operation, follows:

Hydroformer Process Description

The fresh naphtha feed is charged from storage by feed pump J-1 to the gas absorber tower E-1 to recover toluene and other heavy components in the net separator gas. Oxygen, absorbed in the naphtha feed during storage, is stripped by the hydrocarbon product gas, thereby reducing gum formation on the naphtha side of the reactor transfer line heat exchanger C-1.

The enriched feed stream flows to surge drum F-1 where it joins the recycle naphtha. This combined feed plus recycle is charged to the Hydroformer reaction system by the charge pump J-2.

The combined feed stream is heated in feed-effluent exchanger C-1 and naphtha furnace B-1 to 945° F. Recycle gas from the gas separator F-2 is compressed by J-4 and is heated to 1050° F. in recycle gas furnace B-2. The recycle gas and naphtha streams combine and flow downward through reactor D-1 (D-2), where dehydrogenation takes place at 300 psig and an average temperature of 900° F. The reaction products are cooled in exchangers C-1 and cooler C-2. In the gas separator F-2 recycle gas and make gas are withdrawn. The unstable liquid is charged by J-3 to the stabilizer E-2. No hydrogen enrichment system is included since the hydrogen content of the separator gas is sufficient for proper control of dehydrogenation in the reactor.

When reactor D-1 has been on stream for 24 hrs. reactor D-2 is switched in parallel by opening valves 24 and 22. Valve 12 at the inlet of reactor D-1 is then closed. Hot recycle gas for purging is introduced through valve 13 to D-1. Product gases remaining in this chamber are swept into the transfer line for recovery before regeneration. After a 15-min. purge, valves 14 and 13 are closed, isolating D-1 from the hydrocarbon system. Depressuring is next accomplished by opening valve 16, the rate of pressure release being controlled through flow controller to F-4 blowdown stack. As the pressure in the reactor is reduced to about 10 psig, valve 15 in the flue gas outlet line is opened to increase the depressuring rate. When the reactor pressure reaches atmospheric pressure valve 16 is closed and inert flue gas from B-3 is switched from the by-pass line into D-1 by opening valve 11 and closing valve 2. The fuel gas generator is operated to produce 700° F. flue gas with substantially zero oxygen content to purge the catalyst chamber and control the reactor outlet temperature during combustion. When not passing through the catalyst beds, flue gas is by-passed through valve 2 direct to the flue gas stack.

After the flue gas purge is completed combustion air from J-6 blower is introduced into the flue gas stream through valve 1 so that the combined stream will enter the reactor at 700° and leave at not more than 1100° F. The regeneration of catalyst continues for 18 hrs., after which valve 1 is closed and J-6 shut down. Flue gas from B-3 is allowed to increase in temperature to 1100° F., passing through the regenerated catalyst bed, until the average bed temperature approximates 950° F. Flue gas is then by-passed to the stack through valve 2, and valve 11 is closed. The bed then contains flue gas which must be purged from the system and the molybdenum oxide is, after regeneration, in the MoO_3 state. Recycle gas is introduced through valve 13 to reduce the catalyst to MoO_2 and displace flue gas. After 1 hr., valve 15 is closed and the reactor pressure is allowed to build up to 300 psig reaction pressure.

Using equivalent to one-half the make gas the repressure period will require 25 min. Valve 13 is then closed, isolating the reactor from both regeneration and reaction systems. The remaining time in the cycle is idle time, amounting to somewhat

Table 8—Design Utilities Consumption for Planta K on a Per Bbl. Naphtha Fresh Feed Rate

Total High Pressure Steam	64 lbs./bbl. Fresh Feed
Total Cooling Water	8.1 GPM/bbl. Fresh Feed
Tempered Cooling Water	2.3 GPM/bbl. Fresh Feed
Fuel Oil	140,000 BTU/hr./bbl. Fresh Feed
Total KW Light and Power	0.6 KW/bbl. Fresh Feed

less than 2 hrs. In actual operation the burning, reheat and pretreating rates can be adjusted to minimize idle time, which may result in too much cooling of the reactor bed due to radiation before being put into reaction service again.

This cycle is sufficiently flexible so that, if desired, the total time can be reduced to 24 hrs. or less, instead of the 48 hrs. for which it is designed.

In general, the operation of this unit is similar to that of previous Hydroformers. However, since this unit is to be operated primarily for the production of toluene derived from a special narrow boiling feed stock, most of the process variables are fixed within small limits.

Fractionation

The liquid from the gas separator drum F-2 contains a portion of the gas produced in the Hydroformer. This liquid is heated in exchanger C-5 and charged to the stabilizer tower E-2. These light gases are removed from the liquid in this tower and rejected as an overhead product stream which joins the remainder of the make gas from the gas absorber tower E-1 and passes into the fuel gas line. Liquid in equilibrium with the overhead product gas is separted in the reflux drum F-5 and returned to the tower as fractionating reflux.

The stabilized liquid is withdrawn from the bottom of the tower and is partially cooled by exchange against the feed in exchanger C-5. This stream is then charged to the first fractionator tower E-3. Light naphtha containing any benzene produced in the Hydroformer is rejected overhead in this tower, withdrawn and sent to storage. The cut point on this stream will be approximately 85° to 91° C. and will contain essentially all the butanes.

The bottom product from this tower is charged to the second fractionator E-4. The heavy naphtha produced in the Hydroformer is separated in this second fractionator, removed as a bottom product and sent to the fuel oil system. Any phenol contained in the recycle stream to the Hydroformer and not converted into other products is removed with this heavy naphtha fraction. A portion of the phenol, however, will be carried overhead with the aromatic concentrate since phenol in low concentrations is difficult to fractionate.

The overhead from this E-4 tower contains the toluene, unconverted naphthenes, paraffins and other compounds boiling in the same distillation range as this toluene concentrate. This stream is sent to the intermediate storage tanks F-38 and F-39. Since the Hydroformer consists of two catalyst reactors the composition of the effluent can vary throughout the reactor cycle. This toluene concentrate is blended by mixing in this intermediate storage. The resultant stream that is withdrawn and charged to the phenol extractive distillation system thus becomes an averaged product and its composition is fairly constant.

Phenol Extraction

The toluene concentrate is pumped by J-11 from this intermediate storage, preheated by exchange with the phenol in C-11, and introduced at an intermediate tray in the extractive distillation tower E-5. Phenol, which selectively absorbs the aromatic component, is introduced near the top of the tower. The phenol-toluene mixture is removed from the bottom of the tower and charged to the phenol stripper tower E-7 where the crude toluene is recovered overhead. The phenol is taken from the bottom of the phenol stripper tower and returned to the extractive distillation tower via pump J-14 to complete the cycle.

The non-aromatic portion that is not absorbed in the phenol is rejected overhead in the extractive distillation tower as a vapor and charged to the phenol recovery tower E-6. A portion of the phenol is recovered by the trays above the phenol feed tray but a small quantity passes overhead with the non-aromatic portion. Reflux is condensed in the reflux condenser C-12 and returned to the tower. Heat for fractionation and stripping of non-aromatics from the toluene phenol mixture is supplied by the reboiler C-13.

The major portion of the phenol contained in the E-5 overhead vapor product is recovered from the bottom of the phenol recovery tower E-6. However, in small concentrations the volatility of phenol approaches that of heavier hydrocarbons, and its separation from them is difficult. The resulting loss of phenol in this case is approximately 0.4% of the overhead stream. The recovered phenol is withdrawn from the bottom of this tower and pumped to the phenol circulating stream going to the E-5 tower.

Kettle type reboilers are used on the E-5 and E-6 towers for control purposes.

The light naphtha from E-6 tower contains unconverted naphthenes and is split into two streams. One portion is recycled to the Hydroformer feed drum F-1 and the other portion is sent to storage where it combines with the E-3 overhead naphtha.

Provisions are made to recycle this light naphtha and the raw toluene from the E-7 tower to the intermediate storage tanks F-38 and F-39. Thus when the toluene is off grade, i.e., the phenol system is upset or being put on stream, these two streams may be recycled until specification crude toluene is produced.

The crude toluene is contacted with 98% sulfuric acid to remove any remaining olefins in the turbo mixer L-1. Acid is settled in F-11 drum and the spent acid withdrawn. The addition rate of the acid is important and must be controlled carefully. If too much acid is added the toluene is absorbed and is lost as acid sludge.

The acid treated toluene is contacted with weak caustic in the turbo mixer L-2 to neutralize any acid carried over from F-11 settler. Operating experience has shown 5% caustic to be satisfactory. Stronger caustic solutions result in formation of emulsions.

The acid treated toluene is rerun in tower E-8 to remove any acid polymer formed. Some of the salts may be decomposed in this operation so the finished grade toluene is given a strong caustic treatment to remove any decomposition products and at the same time, remove last traces of any moisture that may be present to meet the dryness specification of nitration grade toluene. 50% caustic is recommended for this operation. Gas oil is injected with the feed to dilute the acid polymer in the tower reboiler system and hold the thermal decomposition of this acid polymer to a minimum. Sample points are provided at the overhead reflux drum and at the reboiler circulating system so that a close watch can be kept on the acidity of the system. If decomposition is occurring the rate of gas oil addition should be increased. The acid polymer-gas oil mixture withdrawn from the bottom of this tower is sent to the fuel oil system.

A circulating oil reboiler system is provided to supply heat to all fractionating towers. Any heavy kerosine, Diesel oil, or light gas oil can be used (500° F. to 600° F. boiling range). The oil is pumped by the reboiler oil circulating pump J-27 through the furnace B-4 where it is heated to approximately 600° F. under sufficient pressure to hold the oil in the liquid phase. The hot oil then passes through all units in parallel and is returned to the surge drum F-16. Pressure is maintained on the system by a pressure controlled by-pass which allows oil to flow through the circuit even though no oil should be flowing through any of the exchangers. In this manner the furnace is protected.

The Phenol System

Phenol being an extractive distillation solvent, it is recirculated through the system with very little loss. These losses fall into the following categories:

1) Fractionation loss with the toluene in the phenol stripper tower overhead.

2) Fractionation loss with light naphtha in the phenol recovery tower overhead where the phenol in small quantities forms an azeotrope and is recycled to the Hydroformer reactor

and with the light naphtha product.

3) Chemical combination with diolefins to form a higher boiling material.

4) Pump gland leakage and handling loss.

The first two losses are inherent with the process and can only be held to a minimum by good care in the operation of the fractionating equipment.

The third loss is also inherent with the process and depends on the operation of the Hydroformer. The heavy phenol alkylate or any cresols present in phenol will raise the boiling point of the phenol and result in higher temperatures in the bottom of the phenol stripper tower E-7 and extractive distillation tower E-5. These high boiling materials will gradually accumulate in the phenol. These are removed periodically in a separate tower, so that their concentration is maintained below 4-5%. The cleaning up of the heavy material is accomplished under Operation A for the phenol fractionation tower described below.

The fourth loss results from mechanical and handling leaks from pump glands, valves, etc. This phenol is allowed to drain to a phenol sump and is usually mixed with water (from washing down) and toluene or light naphtha. This slop phenol that is collected in the sump and in the phenol drain tank is transferred to the off-grade phenol tanks. When a tank or so of off-grade phenol is collected the material is charged to the phenol fractionator for removal of water, etc. as described below under Operation B.

Phenol and water at elevated temperatures are soluble in each other in all proportions. However, below 150° F. they will separate into two immiscible layers. At 80° F. the heavier or phenol rich layer will contain 69% (LV) phenol and the lighter or water rich layer will contin 8.5% (LV) of phenol. Phenol and water, however, when distilled will form a constant boiling mixture at approximately 9.4% (LV) of phenol.

Phenol Fractionator

The phenol fractionator tower E-9 contains fractionation trays, a circulating reboiler system, a reflux system and sufficient automatic controls to enable this tower to be operated on either clean-up of heavy material (Operation A), or separation of water and light naphtha-toluene from the phenol (Operation B). This tower can go on "static operation" or operate at total reflux with no feed being sent to the tower or products withdrawn from the tower, and can be switched from one operation to another at will without shutting down.

The reboiler is the forced circulation type in which a portion of the tower bottoms is circulated through the reboiler via pump J-25 and a flow controller. This flow is held constant at all times and the reboiler oil circulation rate is controlled by the tower pressure through a pressure controller. This system maintains the heat input to the tower in balance with the heat output as set by reflux rate and overhead product withdrawal. The bottoms product is withdrawn by liquid level in the tower bottoms through a level controller. The bottoms product can be sent to tankage or the fuel oil system. The feed rate is controlled by a flow controller which is manually set in Operation A and automatically set in Operation B by a temperature controller to hold the overhead temperature constant.

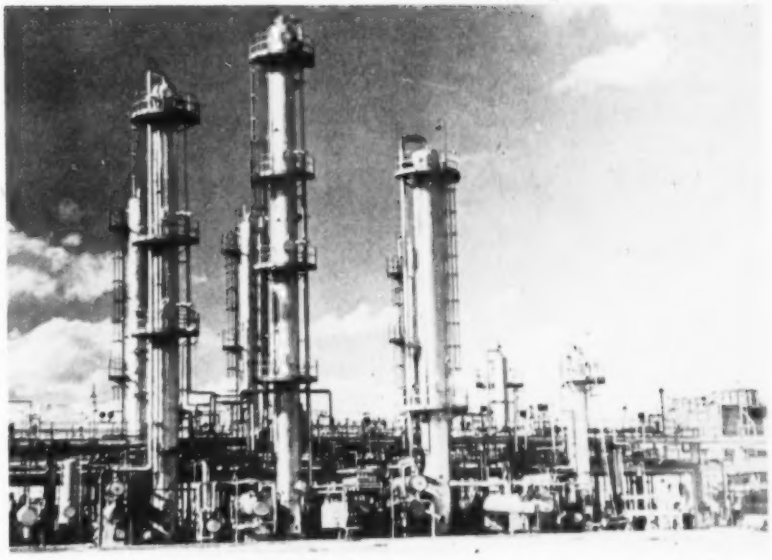
Three separate lines are provided in the overhead system to withdraw products.

1) Purified phenol can be withdrawn via a flow controller and returned to the circulating phenol system or sent to fresh phenol tankage for Operation A. This flow controller will be reset by a temperature controller to hold the overhead temperature constant and phenol product quantity in balance with feed material balance.

2) Water can be withdrawn from the bottom of the reflux drum by means of a level controller for Operation B.

3) Light naphtha and toluene can be withdrawn from the tower during Operation B by observing the tenth tray temperature and controlling the flow through a remote control valve station located in the control room. This material is sent to the intermediate crude toluene tankage. Reflux can be withdrawn from the top or the bottom of the reflux drum and returned to the top tray of the tower via pump J-24 and under flow control.

If for any reason a quantity of phenol containing heavy material has been accumulated, this material may be pumped from tankage to the tower and the purified phenol returned to another fresh phenol tank. The phenol alkylate or other high boiling material separated and recovered from the tower bottom is sent to the fuel oil system. Phenol alkylate has a high melting point (approximately 150° F.) and care must be taken to keep all lines hot. If the high boiling material separated is cresol or any material that will be saved this material can be sent to tankage.



FRACTIONATION EQUIPMENT at Planta K—phenol extraction towers in foreground and Hydroformer fractionation system in background

Tower Operation

Multiple feed tray nozzles are provided in these towers for flexibility of operation. Thus in addition to the variable of tray loading as set by reflux and reboiler heat output-input control, the quality of the products can be controlled to a limited extent by the choice of feed tray being used. With a given heat load on a tower the use of the lower feed tray will mean that more rectifying trays are being used and the overhead product will contain less of the heavy key component and the bottoms product will contain more of the light key component. Conversely if the upper feed tray is used more stripping trays are available and the overhead product will contain more heavy key component and the bottoms product will contain less light key components. In actual operation composition may change and one of the other feed trays may give a better product distribution between overhead and bottoms of any particular tower. These fine points of tower operation are best determined by experience.

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Some Recent Advances in Naphthenic Acid Technology

By JAMES L. JEZL
Sun Oil Co.

NAPHTHENIC acids from petroleum have been an article of commerce for nearly 50 years. During that period they have found ready acceptance, chiefly in the form of metal soaps, for use as driers, lubricant additives, fungicides and, more recently, in Napalm.

Chemically, naphthenic acids are monocarboxylic acids of the naphthene (cycloalkane) series of hydrocarbons. They have the same relation to naphthene hydrocarbons that the fatty acids, such as palmitic and stearic, bear to the normal paraffins.

The commercially available naphthenic acids heretofore have been mixtures of the lower members of the series in the range of about seven to 14 carbon atoms per molecule, and have been obtained by caustic soda extraction of naphtha, kerosine, and gas oil. It is well known, however, that naphthenic acids are not limited to the lower petroleum fractions of crude oil, but extend well up through the lubricating oil fractions. As a matter of fact some refiners, and in particular Sun Oil Co. have been recovering these higher molecular weight acids from lubricating oil fractions largely for their own purposes.

The higher molecular weight naphthenic acids possess 14 to 30 carbon atoms. It has been found that these acids act more like the common fatty acids. Sun has found these acids so interesting in its own applications that it is now constructing a new and larger plant to recover them to the extent of over 10,000,000 lbs. annually. Work is underway to develop their chemical derivatives and potential uses. For the first time the production of higher molecular weight naphthenic acids of a high degree of uniformity will be possible through Sun's new facilities. Products of various average molecular weights will be available to permit application of the right acids to each new need.

Comparison of Properties

The higher molecular weight naphthenic acids differ considerably in properties from the well known low molecular weight product. A comparison of physical and constitutional characteristics is given in Table 1.

The commercial acids currently available possess an average molecular weight ranging between 200 and 275, and the predominating type formulas are $C_nH_{2n-2}O_2$ and $C_nH_{2n-4}O_2$, indicating one to two rings per molecule. In contrast, the higher acids possess molecular weights of from 250 to 450, with average type formulas ranging from $C_nH_{2n-4}O_2$ to approximately $C_nH_{2n-10}O_2$.

Two and three rings per molecule predominate, although more rings are suspected to be present in some molecules. Multiple-ringed molecules are believed to have condensed ring systems in the main. The physical properties of narrow-boiling cuts of naphthenic acids covering a wide range of molecular weights have been reported by Harkness and Bruun[2] and by Goheen.[1]

As molecular weight increases, other properties of the acids also change. The high molecular weight acids are distinguished from the lower by showing properties more like hydrocarbons and therefore possessing a greater compatibility with hydrocarbons, mineral oils, and rubber and other similar polymers. The oil solubility of the metal soaps is also higher for the same reasons.

The important properties which distinguish these high molecular weight acids from the fatty acid mixtures are absence of olefinic unsaturation, good resistance to oxidative rancidity, higher hydrocarbon solubility, and low freezing points. The alkali soaps are in fact so soluble in oil that they generally do not give the characteristic grease structure which is shown by the fatty acid soaps.

Naphthenic acids are unique in that a wide variety of molecular weight products can be secured for special tailor-made applications at comparatively low cost. When the value of the acid depends upon the amount of metal which it can carry, as in driers, the lower molecular weight acids are superior to the higher acids; when emulsification or other surface properties of naphthenic soaps are important, the intermediate acids (M.W. 250-350) are generally best; and for applications in which hydrocarbon solubility or a large hydrocarbon group is desirable, the higher acids are superior.

Reactions and Uses

Naphthenic acids undergo most reactions of carboxylic acids to give rise to valuable derivatives sufficiently different in physical properties from derivatives of fatty acids to be of interest in many industrial applications.

Naphthenic acids react with alkali

Table 1—Physical and Constitutional Data on Low and High Molecular Weight Naphthenic Acids

	Commercial Acids* (Low Molecular Weight)	Sun's Acids* (High Molecular Weight)
Acid Number (Mg.KOH/Gm.)	268	153
Saponification Number (Mg.KOH/Gm.)	271	154
Refractive Index, $n(20/D)$	1.4737	1.5014
Density, $d(20/4)$	0.9783	0.9831
Viscosity SUS/100° F.	220	32,000
Viscosity SUS/210° F.	44	290
Bromine Number	3	7
Carbon, Wt. %	73.17	79.52
Hydrogen, Wt. %	11.03	11.52
Sulfur, Wt. %	0.14	0.15
Oxygen, Wt. %	15.66	8.82
Avg. Molecular Weight	206	363
Avg. Empirical Formula	$C_{14.6}H_{27.0}O_{2.00}$	$C_{24.2}H_{41.1}O_{2.00}$
Avg. Type Formula	$C_nH_{n-2.9}O_2$	$C_nH_{n-6.5}O_2$

* Freed of unsaponifiable matter.

Meet the Author

Dr. James L. Jezl, research chemist for Sun Oil Co. has been associated with the company since 1943, first at their Toledo refinery and since 1946 at the Research and Development Dept. at Marcus Hook, Pa. He received an A.B. degree at the University of Nebraska in 1941 and an M.S. degree at Pennsylvania State College in 1942, doing research on the bacterial formation and oxidation of petroleum. In 1949 he received his Ph.D. degree from the University of Delaware, where he did research on the chemical oxidation of hydrocarbons.

Before joining Sun, Dr. Jezl spent a year with U. S. Rubber Co. at Marion, Ohio as supervisoty chemist of an analytical laboratory. For a number of years he has been engaged in research connected with the properties, reactions, and industrial applications of naphthenic acids.

hydroxides, oxides and carbonates to form alkali soaps. These soaps form more nearly ideal solutions in water than do the soaps of saturated fatty acids and are more soluble in hydrocarbon and other organic solvents for a given molecular weight. Soaps from the intermediate acids in particular are useful in the preparation of emulsifiable oils and specialty products, and as emulsifiers for many purposes, particularly for increasing the rates of reactions which involve two-phase systems.

The alkaline earth and heavy metal naphthenates may be prepared by the reaction of alkali naphthenates with the desired metal salt, or by the direct reaction of naphthenic acids with the proper metal oxide, hydroxide, or acetate. The civilian uses, predominantly for the metal soaps of low molecular weight acids, are found in the paint and varnish industry, in the field of oil additives, and in the preservation of wood, fibers and textiles.

Of even greater potential interest are the organic derivatives of the intermediate and high molecular weight naphthenic acids—the esters, amides, nitriles, amines, alcohols, acid halides, ketones, and their many derivatives. These derivatives have promising uses as plasticizers, solvents, surface active agents, oil additives and ingredients in lubricants for special purposes. Applications are found in the fields of surface coatings, textiles, paper, leather, rubber and plastics.

Simple esters are readily formed by the reaction of naphthenic acids with monohydric alcohols or with olefins. More complex esters are prepared by partial or complete esterification of di- and polyhydric alcohols, ether-alcohols, and other compounds containing hydroxy groups. Naphthenic acids may be used to modify alkyd and a number of other resins. Condensation with ethylene or propylene oxides results in nonionic emulsifiers and surfactants. Esters find use as plasticizers, solvents, softening agents, surfactants, lubricant additives, and in water proofing compositions and protective coatings.

Naphthenic acids react with ammonia to give ammonium soaps, amides and nitriles, the product depending on the reaction conditions. These products in turn may serve as intermediates for a wide variety of reactions. Amides may serve as dyeing aids and stabilizers, wetting agents, dispersants, oil additives and water repellents. Nitriles have been proposed as textile lubricants, oil additives, plasticizers and solvents. Hydrogenation of nitriles results in amines. Amines, amine salts and derivatives have a wide variety of uses for purposes such as flotation agents, dispersing agents, corrosion inhibitors, agents in the processing and dyeing of textiles, binders for asphalt, surface active agents and fungicides.

Naphthenyl alcohols are formed by the chemical reduction or catalytic hydrogenation of naphthenic acids or their simple esters. They are valuable chiefly as chemical intermediates, surface modifiers, solvents and components of special lubricants.

The acid halides and anhydrides are of value chiefly as intermediates.

Ketones may be prepared by the Friedel-Crafts ketone synthesis, or by pyrolysis of metal naphthenates. They have been proposed as insulating, dielectric and moisture proofing agents, as lubricating oil additives, and for use in the plastics and resin field.

The commercial possibilities of naphthenic acids are far from exhausted. Entirely new fields of application are bound to open for the intermediate and high molecular weight acids as they become available.

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(1) Goheen, G. E., *Ind. Eng. Chem.*, 32, 503 (1940).
(2) Harkness, R. W., and Bruun, J. H., *Ind. Eng. Chem.*, 32, 499 (1940).

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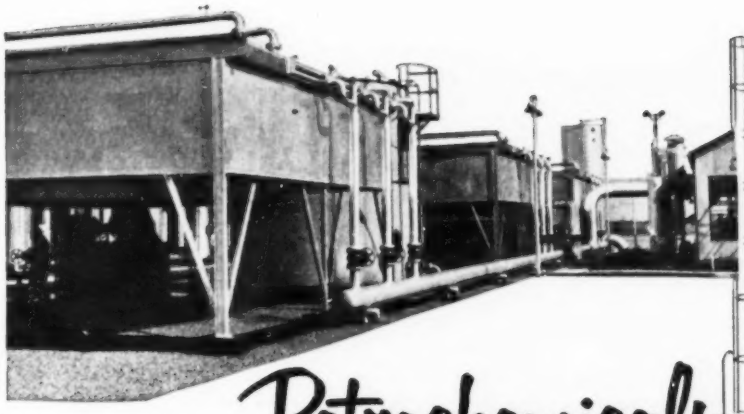
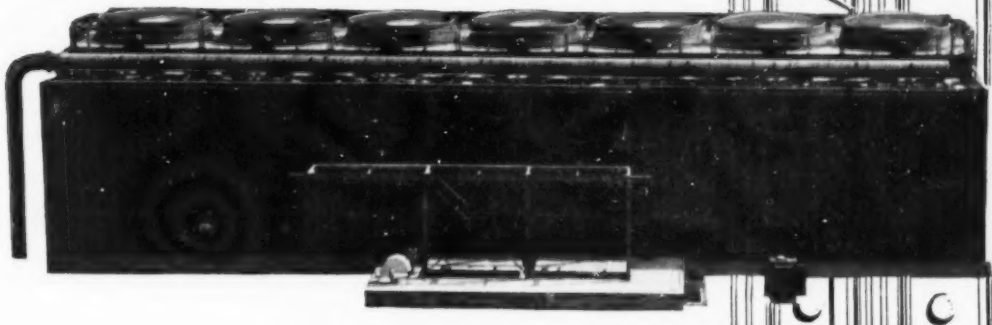
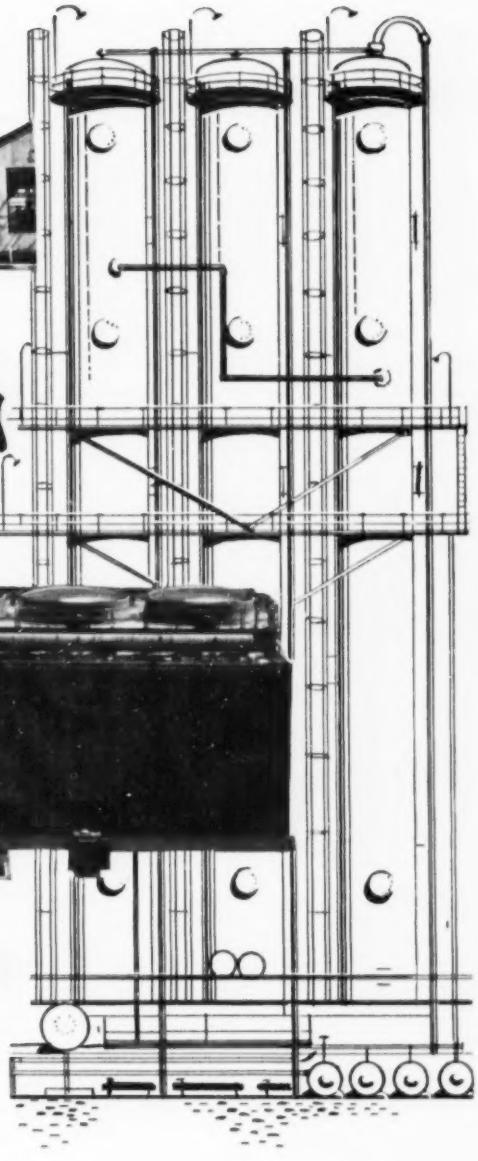


Petrochemicals

Americas "hottest" industry...





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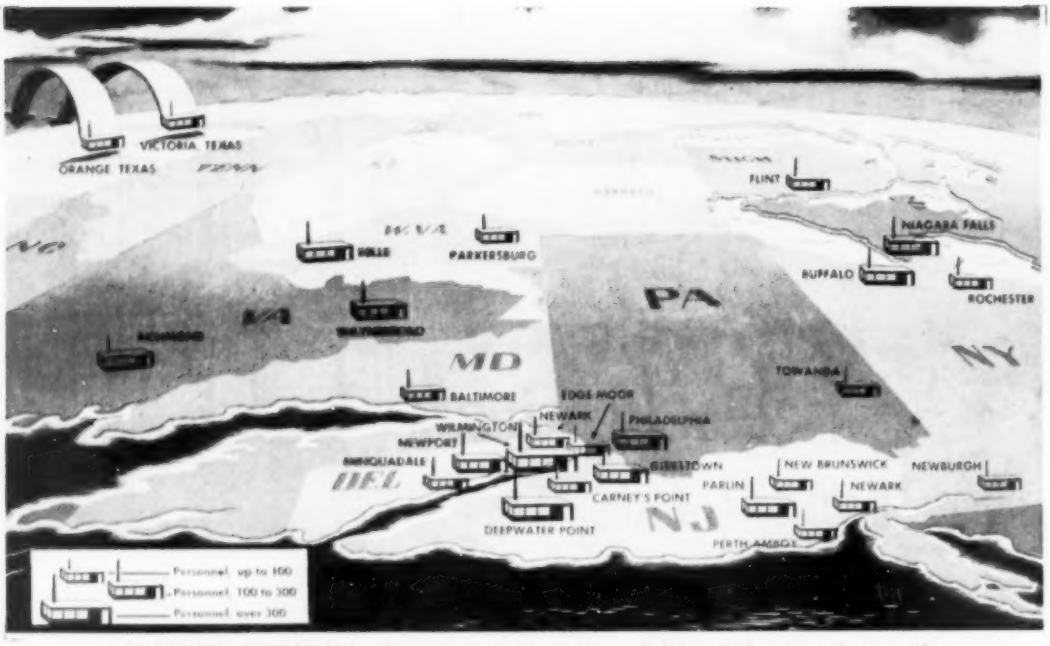


DU PONT'S NETWORK of research and development laboratories spreads over the country, with 40 laboratories at 26 locations

The Du Pont Story—RESEARCH

Experimental work widely applied to make chemicals both from and for petroleum

By V. B. GUTHRIE, Editor

IN THE vernacular of the chemist, the petroleum industry is double-bonded to the Du Pont Company, just as two "affinities" exist between the carbon atoms in some of the compounds coming from the petroleum raw material.

The chemical company manufactures a large number of products used extensively in all branches of the oil industry. Du Pont is also turning increasingly to petroleum and natural gas for raw materials used in its manufacturing processes. Also, just as two bonds mean to the chemist unsaturated compounds, so the relatonship between Du Pont and the petroleum companies is undergoing expansion and by no means has the saturation point been reached.

Thus, the petroleum industry has played an important part in the growth of this largest chemical manufacturing company in the world, E. I. du Pont de Nemours & Co., which last year celebrated a remarkable event for an American industrial concern—its 150th anniversary of business life. Starting in 1802 to make black gunpowder in a tiny plant on the banks of Brandywine Creek, near its present headquarters of Wilmington, Del., Du Pont today has 71 manufacturing plants in 25 states, 40 research and development laboratories, employs 87,000 people and makes several thousand chemical products.

Included in the manufacturing plants are two in Texas—relatively new—which make use of petroleum and natural gas as basic raw materials in the manufacture of a variety of products, including methanol, polythene plastic, and nylon intermediates.

Concerning the mutual dependency of the chemical and petroleum industries, J. Warren Kinsman, a Du Pont vice president, in a talk before oil men in Texas a few months ago, said that World War I had shocked the chemical industry into a realization of its dependency on German chemicals and had made the petroleum companies see how great the need for automotive fuels and lubricants and others of their products would be in future wars.

"The petroleum people then threw away their cook books and jointly with inorganic chemical manufacturers began in earnest the study and practice of organic chemistry," he said. "During the past 35 years these two industries have forged ahead, shoulder to shoulder, to make some of the greatest and most remarkable discoveries of history; to create new products for our way of life, and to become absolutely indispensable to our national security."

A great deal of the credit for the great expansion and vigorous business life of the Du Pont Company is assigned to its long-standing and far-sighted research program. The founder, Eleuthere Irenee du Pont a pupil of the great French scientist, Lavoisier, had the utmost respect for research. In 1804, two years after the start of the company, he took out a patent for an improved method of granulating gunpowder.

Formal Research Started in 1902

In 1902, the company established its first formal research laboratory at Gibbstown, N. J., with a staff of six chemists.

In 1927, Du Pont launched a program of fundamental research, with the purpose of uncovering basic scientific knowledge, without regard for specific commercial objectives. It is since that time that the company has experienced its greatest growth. Among the best known results of its fundamental research program

are neoprene, the first successful general purpose synthetic rubber, announced in 1931, and nylon, the first truly synthetic fiber, announced in 1938.

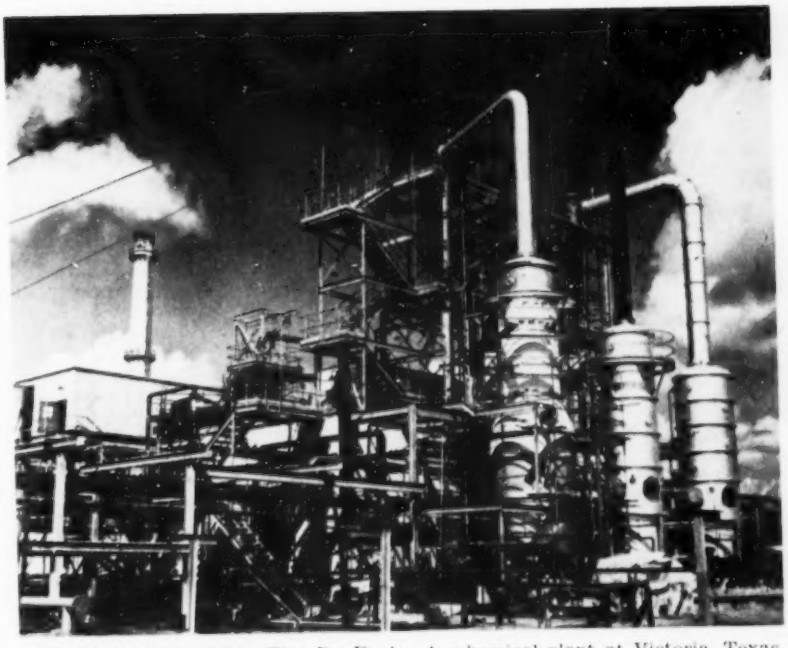
Evidence of the importance that Du Pont assigns to research today is supplied by its annual expenditures in this branch of its business. The company in 1951 spent $47,000,000 for research, exclusive of new facilities. This was better than 21% of its net income for that year of $220,743,811. It costs the company on the average $24,000 a year to maintain one technically trained man in research and involves an average of over $30,000 in laboratory facilities.

The petroleum industry ranks well towards the top with its own research expenditures, the total today being probably over $110,000,000. The relative proporiton of individual oil company expenditures for this purpose hardly compares with that spent by Du Pont. Standard Oil Co. (New Jersey) and its affiliates in 1951 spent $23,100,000 in the conduct of research. This was 4.4% of its consolidated net income of $528,461,000. Socony-Vacuum Oil Co. spent around $11,000,0000 for research in 1951, which was 7% of its net income of $162,000,000. While but few oil companies report their research expenditures separately, in no cases, as far as is known, does the figure run over 10% of net income.

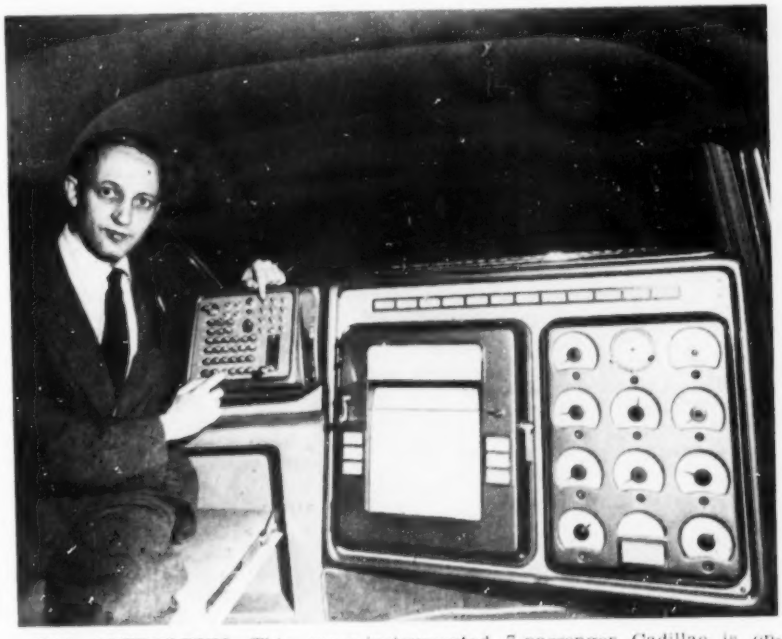
Through its early start in research, experimental work in the field of explosives was already going on when the petroleum industry first became a large user of a Du Pont product, explosives in "shooting" oil wells. The horsedrawn wagons that pulled through the mud and dust of the western Pennsylvania oil towns in the early days of oil production there carried a Du Pont product. Special explosives were later developed for seismic prospecting for oil fields. Oil companies over the years became large users of acids for stimulating production of oil wells, paints, dyes, special types of rubbers and many kinds of chemicals used in refining and treating petroleum and its products. For the most part these were standard products made by Du Pont for wide usage and applied to oil company purposes.

TEL Work Dates Back 30 Years

Beginning in 1922, however, with laboratory work to develop a process for manufacturing tetraethyl lead to be used as a suppressant for the knock in automobile engines, the Du Pont Company launched an extensive research program in behalf of the petroleum industry. This work was done in Jackson Laboratory, at Deepwater Point, New Jersey, which had been founded in 1917 for research on dyes and intermediates. This particular research led to the development of the ethyl chloride method for making tetraethyl lead and in 1924 the first full-scale ethyl chloride process plant was built. During the past 25 years the Du Pont Company has made



FROM PETROLEUM—This Du Pont petrochemical plant at Victoria, Texas, converts butadiene to adiponitrile, a nylon intermediate, and is operated by the company's Polychemicals Dept.



FOR PETROLEUM—This super-instrumented 7-passenger Cadillac is operated by Du Pont's Petroleum Laboratory to road test various gasolines. Instruments on right indicate car speed, engine speed, throttle position, fuel flow, spark advance, horsepower, miles per gallon, axle torque, exhaust pressure, manifold vacuum, and temperature (at six points). X-Y recorder to left of instruments plots any one of six variables (spark advance, horsepower, torque, miles per gallon, miles per hour or throttle position) on the Y axis against time in seconds, miles per hour or engine RPM on the X axis

more than 2,000,000,000 pounds of tetraethyl lead compounds.

In 1931, Jackson Laboratory, which had become the main research laboratory for Du Pont's Organic Chemicals Dept., started the study of the oxidation of gasoline in storage. Experimental work in the field of fuels and lubricants developed rapidly and in 1938 the Petroleum Laboratory was started, also at the Chambers Works at Deepwater Point. A considerable portion of the work at Jackson Laboratory now is in the development of new chemical compounds for use as anti-knock agents and other petroleum additives.

The work at the Petroleum Laboratory, which is still expanding, embraces three separate activities in the field of chemicals for fuels and lubricants — fundamental research, product development, and technical service to the petroleum and automotive industries. Available for this work are chemical and engine laboratories as well as extensive facilities for servicing and overhauling road test vehicles. DuPont maintains a fleet of fuel test vehicles for customer use.

Research investigations range from studies of the mechanism of fuel oil deterioration to studies of the complex chemistry of combustion chamber deposit scavenging and the knock reaction. The experimental techniques for studying the reactions leading to knock employ unfired single-cylinder engines as reaction vessels in which the air-hydrocarbon mixtures are compressed to any desired temperature and pressure. Unique sampling valves are used to sample the reacting gases and collect them in receivers at dry ice temperatures. These condensed products analyzed by chemical and spectrometric methods give the clues to the oxidation mechanisms which cause knock.

Radioactive tetraethyl lead has been used for studying the migration of deposits in combustion chambers and the mechanism of deposit flaking. Experimental installations for studying the heat transfer characteristics of deposits are being used on a routine basis.

A Philosophy of Research

The Du Pont philosophy of research is plainly evident in all this work. The general approach to a problem is first to learn about the chemistry of what is happening and then to utilize this knowledge in the search for materials which will cause the desired reactions or eliminate the undesired ones. This approach is being used in both the Jackson Laboratory and the Petroleum Laboratory in work on new antioxidants and detergents for lubricating oils, antioxidants for gasoline and fuel oils, additives for scavenging combustion chamber deposits, and additives to improve the efficiency of tetraethyl lead as an anti-knock agent in the presence of the sulfur compounds usually found in gasoline. Chemical additives are first screened in accelerated tests, followed by full-scale laboratory engine evaluations and road tests of the more promising materials. When developed into commercial products, their sale is through the Petroleum Chemicals Division of the Organic Chemicals Department, one of the ten departments of Du Pont, each of which conducts its own research, production, and sales activities.

While the sale of Du Pont products of all kinds today to the petroleum industry are growing, they constitute only about 4% of the company's business, and petroleum producing and refining ranks eighth in volume among industries served. The textile industry, taking chiefly dyes and the man-made fibers, is first with around 28% of the company's business. The automotive industry is second with 9%, using chiefly lacquers, plastics, and chemicals.

And Now—Petrochemicals

Research has also played a part in the second relationship of the Du Pont Company with the petroleum industry, namely, the use of petroleum raw or intermediate materials in the manufacture of its wide range of chemical products. Economics has been an important factor here, too.

Du Pont has long used petroleum raw materials in its manufacturing operations. The old V M and P naphtha, as well as turpentine substitutes, was being used in the manufacture of paint when Du Pont acquired The Harrison Brothers Paint Co. in 1917.

At its Sabine River Works at Orange, Texas, Du Pont manufactures methanol and "Alathon" polythene resins, or polyethylene plastic. Methanol is derived from natural gas and is used in many of the non-permanent types of automotive anti-freeze. Large quantities of it are also used in the manufacture of formaldehyde, another Du Pont product. The Orange plant also uses large quantities of petroleum cyclohexane as a primary material in its nylon process.

Du Pont has been making ethylene at the Orange plant from propane, but as expansion of "Alathon" capacity progresses it will be a large consumer of ethylene from the petroleum industry in Texas.

Ethylene oxide also is obtained from ethylene. One of the derivatives of ethylene oxide is ethyl chloride which is used by Du Pont as a major reactant in the production of tetraethyl lead. Ethylene dichloride and ethylene dibromide, another derivative of ethylene oxide, are present in substantial proportions in tetraethyl lead anti-knock compounds for motor gasoline, while ethylene dibromide is used in tetraethyl lead anti-knock compounds for aviation fuel.

Ethylene oxide is employed by Du Pont as a softening agent, or plasticizer, for collophane. Ethylene glycol may be made from ethylene oxide, and Du Pont is interested in the latter material for the manufacture of its new "Dacron" polyester fiber. Ethylene glycol is the basis of the permanent automotive anti-freeze. Du Pont produces ethylene glycol from methanol.

Acrylonitrile is a derivative of ethylene oxide and this material is of major importance in the manufactre of "Orlon" acrylic fiber.

Another derivative of ethylene is ethyl alcohol from which ethyl acetate is obtained. Du Pont uses both as solvents.

Isopropyl alcohol, from propylene, is employed by Du Pont as a primary solvent by its Finishes Division, while acetone, from isopropyl alcohol, is used in the manufacture of "Lucite" acrylic resin, another plastic, and as an ingredient of acetate rayon in addition to its many uses as a solvent. Propylene glycol, derived from propylene oxide through propylene, is an ingredient of the permanent anti-freeze and brake fluid.

Propylene also is the basis of synthetic glycerine which Du Pont consumes in considerable quantities in the manufacture, for example, of commercial explosives and as a softening agent for cellophane.

Not so long ago, Du Pont started operations in a new plant at Victoria, Texas, for the manufacture of adiponitrile, a chemical used in making nylon. The primary feed stock at Victoria is butadiene, from the petroleum industry, and natural gas also is used in the process, other than as fuel.

Para-xylene, one of the isomers of xylene, an aromatic obtained by the dehydrogenation of naphthene, is used in making terephthalic acid from which dimethyl terephthalate may be derived. Dimethyl terephthalate is a major component in the manufacture of "Dacron" polyester fiber. Ortho-xylene, another isomer of xylene, is the starting material for phthalic anhydride, a base material in the alkyd-type of resin finishes.

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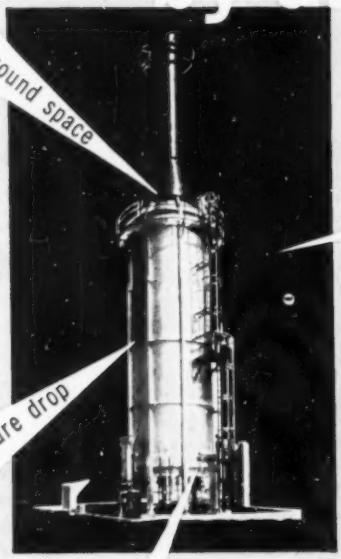

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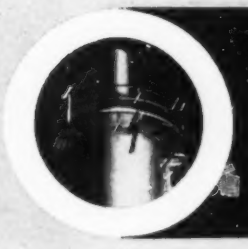

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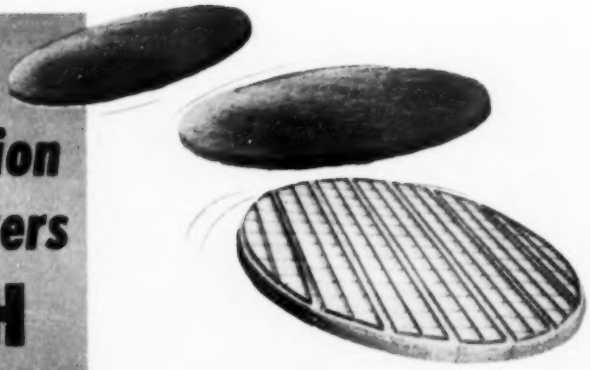

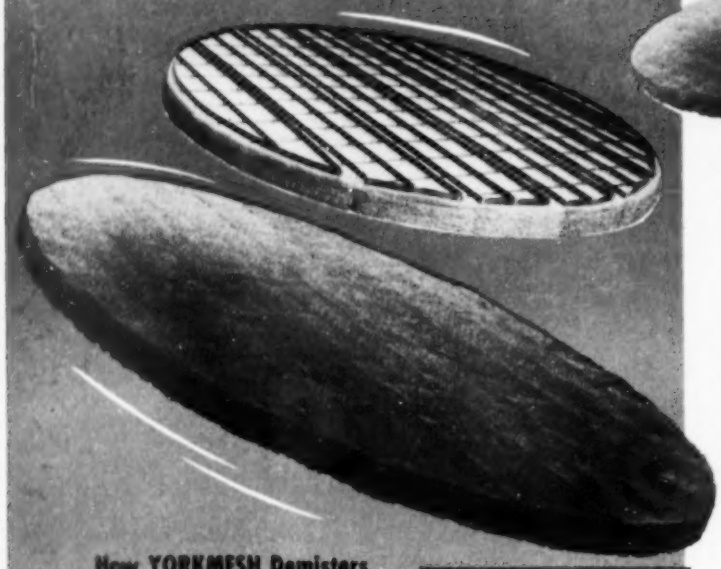

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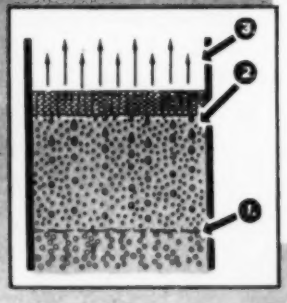
3. *The vapor is now dry. It has been entirely freed from entrained liquid. Thus a clean gas-oil goes to the catalytic cracker.*



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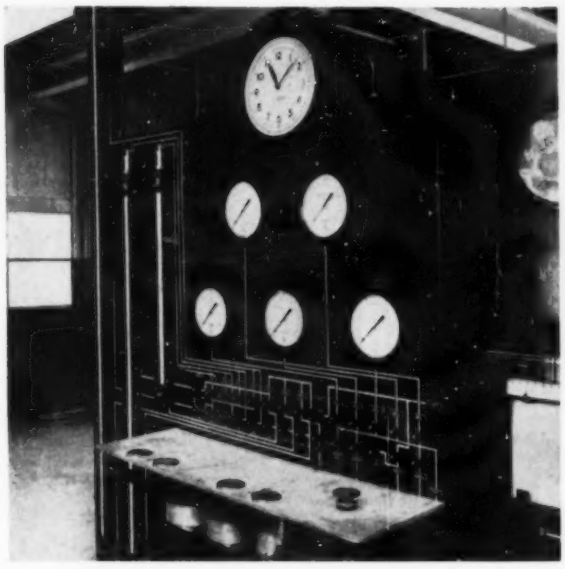
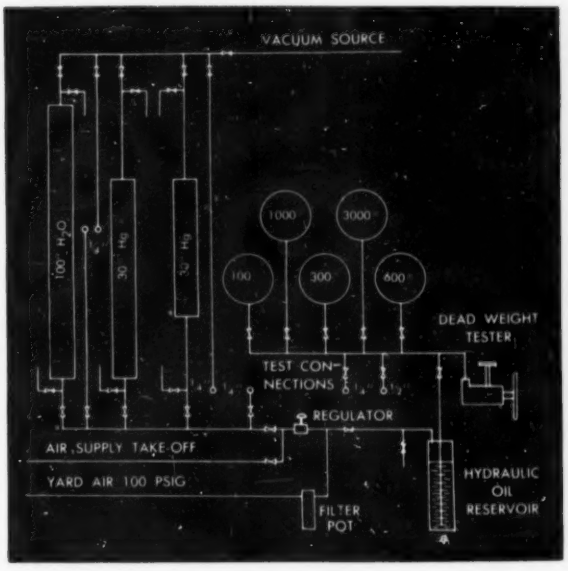




Instrument Tests Easy on "Graphic" Panel

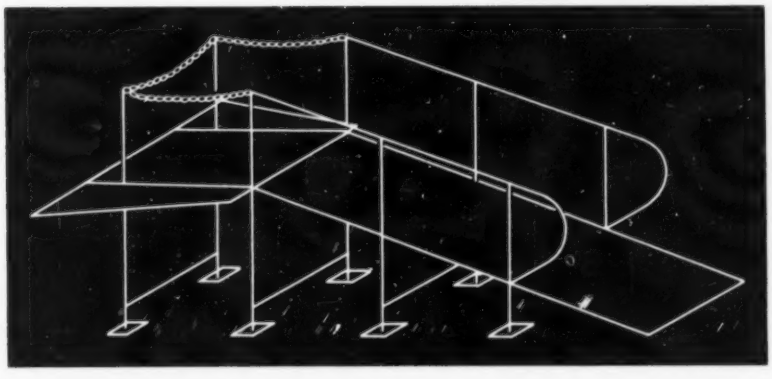
By ROBERT L. PATTON*

THE graphic panel technique has been applied to advantage in building an instrument test panel at the Cleves, Ohio, refinery of Gulf Refining Corp. Shop men had only recently constructed a new test panel. However, they found it still a trifle confusing at times, even with nameplates identifying the various valves, so they made a "graphic" out of it, as illustrated in the photograph, and shown diagrammatically in the sketch.

A color scheme in addition to the use of the lines helps further. The hydraulic oil system is done in yellow, the air pressure system is in white, and the vacuum system is blue. The "flow" diagram painted directly on the panel greatly simplifies the task of "lining up" a test to be made, particularly since no single man works with the test panel continuously, but rather all the instrument men use it occasionally.

For example: one of the more complicated set-ups is a calibration on a differential pressure transmitter. Air supply is connected to the transmitter, and vacuum is applied to the low side and measured with the 100-in. water column. Air output is measured on the 30-lb. Hg. column. Such an arrangement is very easy to trace through by following the lines on the front of the panel.

* Mr. Patton, a previous contributor to PETROLEUM PROCESSING, is instrument engineer, Gulf Oil, Pt. Arthur, Texas, where he was transferred recently from the Cleveland, Ohio, refinery.



Ramps Speed Scrap Removal

Faster material handling and better plant housekeeping has resulted from use of a series of loading ramps installed at various scrap, refuse and miscellaneous collection stations in the Philadelphia refinery of the Atlantic Refining Company.

Designed for use with the so-called "Up-Sa Dazey" dumping skid, or trough, the ramps permit direct dumping of materials into the container as they are brought to the collecting station. Previously, material was simply piled up alongside the skid until some suitably large material handling crane or scoop truck came along to finish the job. Details of the ramp are shown in the accompanying drawings.

Main frame construction is of 1½-in standard pipe, with welded joints. The upper platform is 4 ft. above grade: the ramp itself is 16 ft. long and has about a 14½° slope. The platform is about 6 ft. long, and tapers in width from 5 ft., 2 in., to 6 ft., 2 in. The ramp is 4 ft., 2 in., wide throughout its length. Ramp and platform floors are 2 x 10 in.

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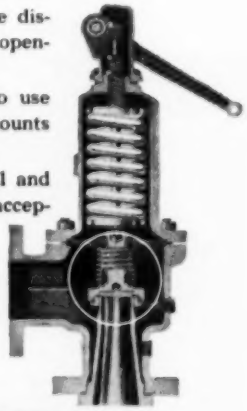

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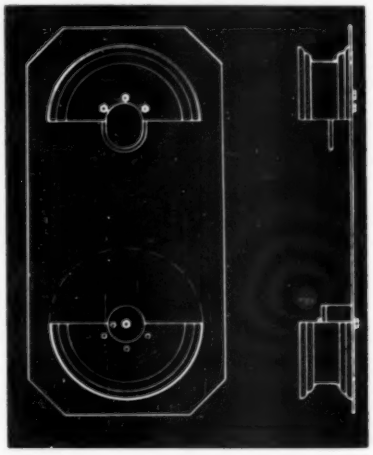
planks laid crosswise on 2 x 2 x ¼ in. The ramp is 4 ft., 2in., wide throughout its length. Ramp and platform floors are 2 x 10 in. planks laid crosswise on 2 x 2 x ¼ in. angles for supports. Guard rails on the ramp are made of 1-in. bar. The platform has ¼-in. chain in place of the rail. To prevent the structure from sinking into the ground, the bottoms of all the vertical 1½-in. posts have 8-in. square, ⅜-in. plate feet.



Old Wheels Are Good As Rope Storage Rack

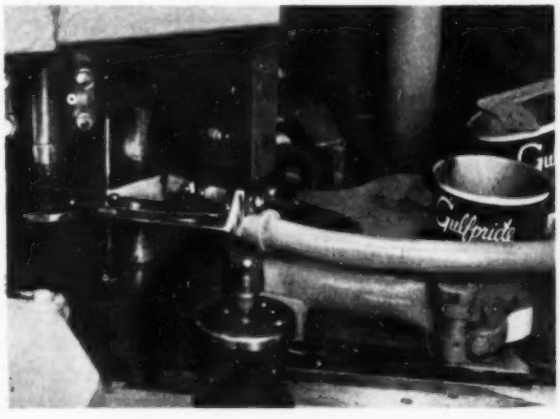
By ZACK BENNETT*

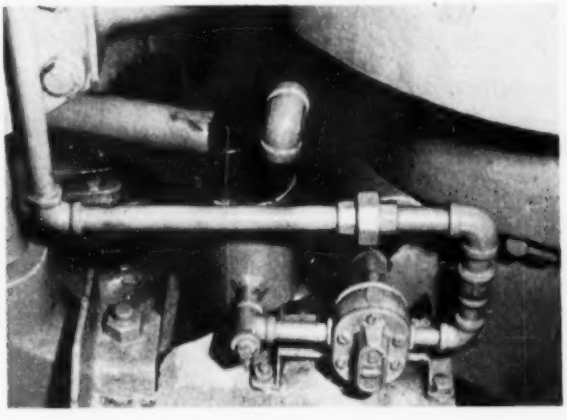
AN OLD automobile wheel cut in half provides neat storage for block and tackle, using a minimum amount of space, aiding in good housekeeping, and keeping the rope in good shape for quick removal for use.

As shown in the sketch, the halves of the wheel have been mounted approximately 18 in. apart on a panel, which can be wood or steel. The panel is mounted on any convenient wall space. The amount of rope to be stored will determine more exactly the distance between the wheel halves. The top half is mounted rigidly and has a loop bolted at the center for hanging the blocks after they have been drawn together, or "two-blocked" on the rope. The bottom half of the wheel is pivoted on a bolt at the center.

In storage the rope is coiled firmly around the two half wheels. When it is to be removed, the bottom half is swung to either side far enough to provide sufficient slack in the loops of the rope to permit the entire coil to be taken down without unwinding.

* Mr. Bennett is associated with Continental Oil Co., Basile, La. The fore-going short item is based on his prize-winning idea presented during the "Plant Kinks" session of the Natural Gasoline Ass'n. of America meeting, October 24, 1952, at Tyler, Texas.





How to Cut Drip Losses in Can Filling

IN high speed, small can-filling machines with multiple nozzles there's always a certain amount of oil dripping from the nozzle between filling cycles. This tends to cause an annoying housekeeping chore and in addition it is wasteful since the drippings usually are collected as waste.

By installing a simple collecting and salvaging system on the quart-can filler in the Package Department of their Philadelphia Refinery, Gulf Oil Corp. estimates they save about 40 gal./day of good oil when the machine is operating at its normal 200-qt./min. filling rate. The photographs show how the system works.

At the left is seen a small rubber wiping blade mounted so that it removes drippings from each nozzle passing over it as the machine revolves. Drippings collect in a small catch pan and then flow through the 1-in. pipe to the assembly shown in the picture at the right. Here the oil passes by gravity through a 100-mesh screen filter. Then it is picked up by a small gear pump and sent up to the filler reservoir.

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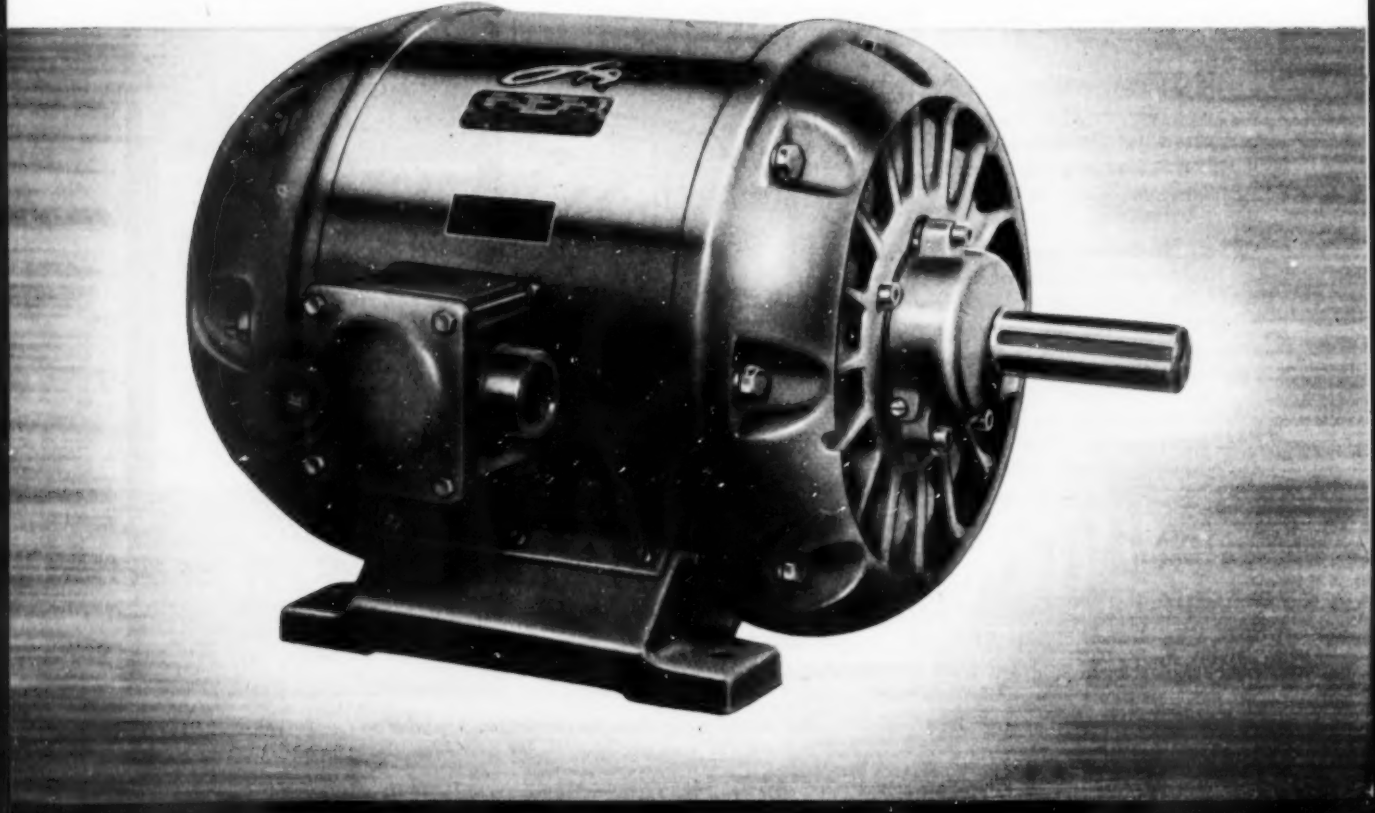

MASTER SPECTRUM, showing identification lines for iron and vanadium

FAST SPECTROGRAPHIC METHOD FOR

Metal Impurities in Cracking Feed

THE Texas Co. at Port Arthur, Texas, is using a rapid spectrographic method for the determination of minute quantities of heavy metals in catalytic cracking stocks as a tool in studies for improving catalytic cracking operations. The heavy metals, particularly iron, vanadium and nickel, appear in quanties so small as to render impractical the conventional methods used in chemical analysis.

Although present in the charge stock in concentrations of only a few parts per million, sufficient quantities are laid down on the catalyst by accumulation to "poison" it, necessitating greater make-up ratios of new catalyst if a loss in "activity" is to be avoided. Mills[1] and others have shown that poisoning of cracking catalysts is permanent when small amounts of iron, vanadium, nickel and copper are adsorbed on the "active" centers of the catalyst surface which are involved in the cracking reaction. They cannot be removed during regeneration even by raising temperatures to the catalyst sintering point.

The advantage of using emission spectrographic methods for determining metal contaminants is that reliable results can be quickly obtained at low cost. The elapsed time from acceptance of sample to issuance of analytical results can be as short as an hour to a day for spectrographic methods, but usually from a day to a week for chemical methods. Also, the use of small quantities of sample required in emission spectrographic methods is an advantage in laboratory or pilot plant operations where it is undesirable to withdraw the larger amounts of oil necessary for analysis by ordinary chemical procedures.

Conventional methods of chemical analysis — colorimetric, gravimetric and volumetric — are capable of measuring even minute amounts of the heavy metals, given sufficient sample. But they require tedious, time-consuming operations and may involve the destruction of sample ranging in size from a few ounces to a gallon or more. Sometimes other substances also present in the sample may interfere with the determination of "wanted metals" and thus complicate the analysis by involving further chemical manipulation to remove or minimize the interference.

This comparison of the two general methods is well-known at Port Arthur for the application under discussion, since chemical methods were used to correlate spectrographic data into charts used for calculating quantities present.

The 'Direct Method'

There are two spectrographic methods which could be used. One is the classical procedure involving ashing and calcining the sample before placing it in the electrode and sparking or arcing. Chemists will readily recognize this as similar to the early steps in a chemical analysis.

The other, the so-called "direct method" first advanced by Calkins and White[2], has been modified for use at Port Arthur because it is rapid and eliminates entirely the tedious ashing of sample.

In this method the oil itself is introduced directly into the arc or spark and resulting radiant energy is analyzed into a line spectrum by means of a slit and diffraction grating. The photograph made of the line spectrum is examined in a "Comparator Densitometer" along with a master record similar to that shown above.

This permits qualitative and quantitative estimation of the various metals present by the relative densities of the corresponding spectral lines on the "master" and "unknown" films.

With this procedure a part per million or more of contaminant can be detected in an oil. The size of sample may be one milliliter or more. An "internal standard" is used to give a comparison reference as a check on excitation and exposure variations occurring among analyses. That is, it tends to effect a cancellation of the influence of variations in exposure, excitation and film development on the spectrographic determination of an element.

For the internal standard, cobalt in an oil-soluble form is usually suitable. Oil-soluble cobalt oleate is easily prepared by treating cobalt acetate with oleic acid[3].

Excitation Technique

A few drops of the oil containing the internal standard are placed in a cup in the lower electrode, if the use of such a restricted amount of sample is compatible with essential sensitivity, or a milliliter or more of sample is accommodated by using an upper hollow electrode which will drip the oil into the spark gap. The oil feeds into the gap through a small hole (No. 8 twist drill) bored through the bottom of the chamber in the upper hollow graphite electrode.

The sample is then sparked for a definite time, such as 20 seconds. Where desirable in order to obtain proper exposure of photographic film, it may be sparked until all sample is consumed and then additional sample added and sparked.

An example of an analysis procedure at Port Arthur calls for the addition of 1 part of an oleic acid

solution containing 1% cobalt to 10 parts of oil sample. The sample is chosen sufficiently large to minimize measurement error in adding the internal standard on the accuracy of the analysis.

A third of a milliliter or more of sample is placed in the hollow electrode and the analytical gap—distance between the upper and lower electrodes—set at 5.0 mm. The excitation source is set to give a high voltage spark based on 3½ amp. primary current, producing 6½ amp. discharge current. Sparking time is 20 seconds (or more) and a slit width of 60 microns is used.

The instrument used is an Applied Research Laboratories 1.5 Meter Spectrograph with an original grating giving a dispersion of 6.9 Angstrom units per millimeter over the First Order spectrum and twice that dispersion, or 3.45 Angstroms per millimeter, in the available Second Order. For analyzing oils for metal contaminants the First Order gives sufficient dispersion.

The excitation source is an A.R.L. "High Precision Source Unit." An A.R.L. Film Comparator-Densitometer is used to measure the percentage transmission of light through the selected spectral line for the element desired.

The film used is 35 mm. Kodak Spectrum Analysis No. 2. Development is accomplished with Kodak D-19 Developer at 77°F. for two minutes, short stopping with Kodak SB-3 Chrome-Alum, and fixing in Kodak F-7. The film is washed in running water for 30 minutes and air dried.

Calculations

The radiant energy emitted during controlled excitation is qualitatively and quantitatively a function of the metals present in the sample. Hence, the respective spectral intensity registered on photographic film is a measure of the amount of the element present. The intensity of spectral energy emitted by iron, nickel, or vanadium in a sample is measured relative to the intensity of energy emitted by the fixed percentage of the internal standard (cobalt). Therefore this ratio of intensities, when compared with ratios obtained from chemically analyzed reference standards, indicates the definite percentage of metal contaminant in the oil.

References

(1) Mills, G. H., "Factors Controlling Aging of Cracking Catalysts," presented before Western Petroleum Refiners Ass'n., Lake Charles, La., Feb. 23, 1951.

(2) Calkins, L. E., and White, M. M., "Analyze Additive Lubricants in Minutes Instead of Hours with Spectrographic Method," *National Petroleum News* Technical Section, Vol. 38, No. 27, p. R519-R530 (July 3, 1946).

(3) Carlson, M. T., and Gunn, E. L., "Determination of Trace Metallic Components in Petroleum Oils," *Anal. Chem.* 22, 1118 (1950).

Picture Credit

Illustration of master spectrum courtesy of "Spectrochemical Procedures," by Charles E. Harvey, Fig. 2.13, p. 42, Applied Research Laboratories, 1950.

What's Your Headache?

A man out in California is looking for a good method for designing bench-scale and semi-pilot-plant equipment. Have you an answer? Send it in. It's good material for this Laboratory Practices section.

Or perhaps you have a problem of your own. Send it in also. We'd like to help you on your "headaches" if we possibly can. If you wish, we'll keep it all anonymous. The important thing is your problem and its solution.

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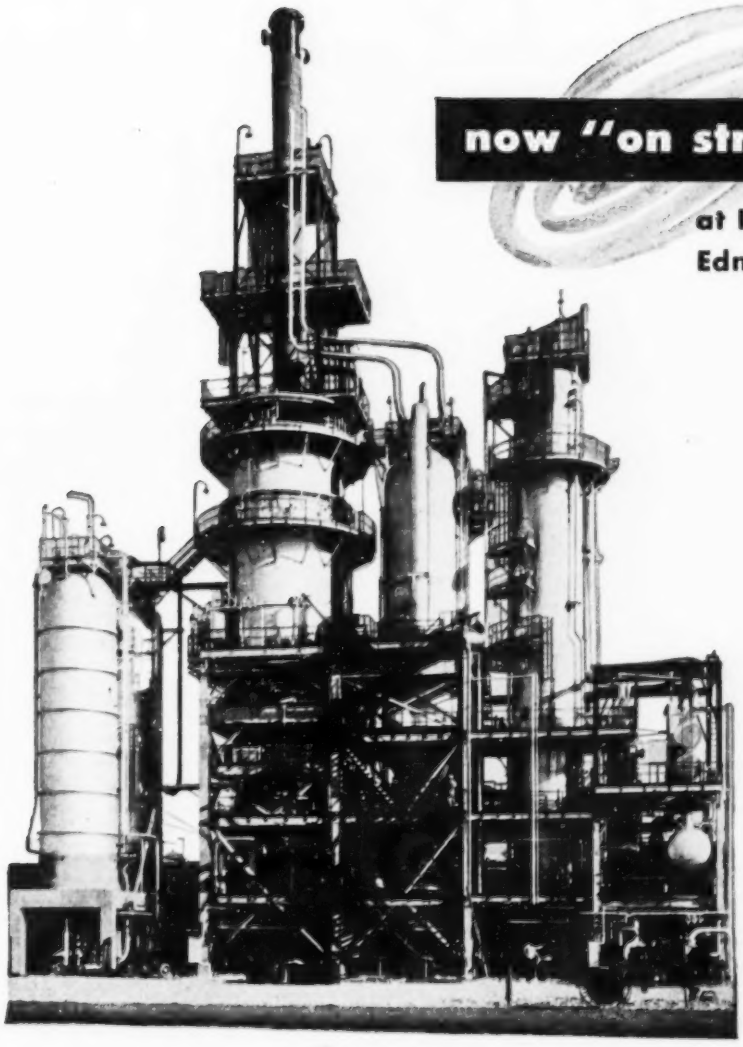

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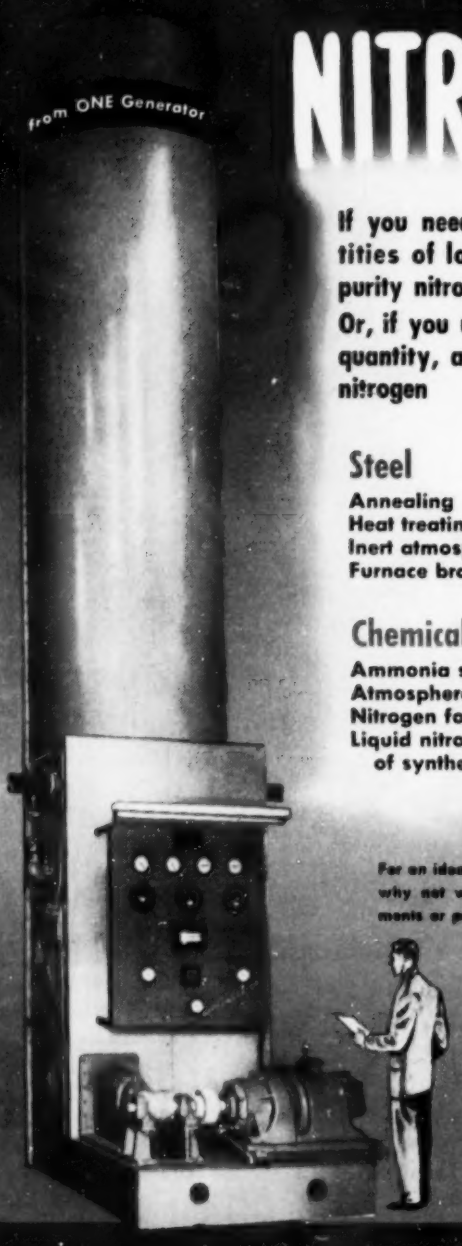

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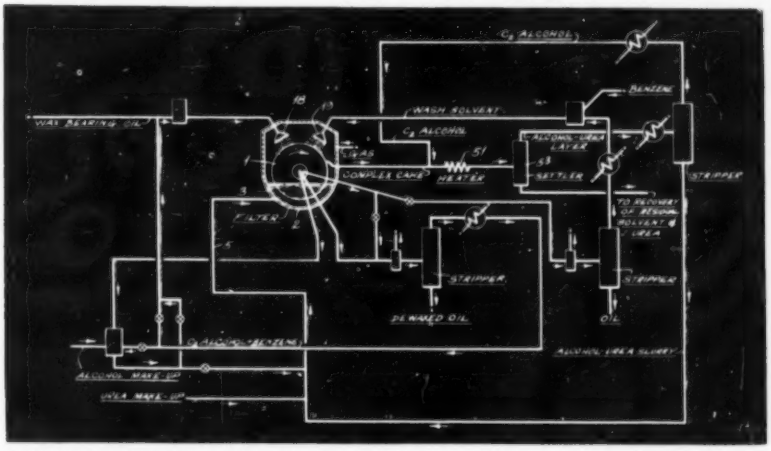
OXYGEN-NITROGEN GENERATORS

By Peter J. Gaylor, *Patent Attorney, Gaylor, Cifelli & Jurick, Newark, N. J.*



DEWAXING PROCESS developed by The Texas Co. and employing urea as a complexing reagent (U. S. 2,606,140)

Urea Serves as Complexing Reagent To Remove Paraffinic Hydrocarbons

THE use of urea as a complexing reagent for removing paraffinic hydrocarbons from mixtures is a relatively new development which is said to have originated during the last war in Germany. There have been some patents issued on this development in this country, and one of the recent ones is The Texas Co. patent 2,606,140 dealing with separation of wax constituents in oil.

In the case of separating wax from mineral oil, the urea complex appears to be a definite chemical compound, consisting of about 25% wax and 75% urea by weight. The crystal structure appears to be hexagonal, and complex formation is facilitated by the presence of a small amount of alcohol, water, or other polar liquid capable of dissolving urea. The complex forms at ordinary temperatures (to 125° F.) and may be decomposed by heating to 150°-180° F. or higher.

The patent describes a method for complexing and removing the complex from the liquid by filtration, preferably by means of a drum filter such as that shown in the Kiersted patent 2,449,902.

A diagrammatic flowsheet of the process is shown above. A slurry 3 of urea crystals suspended in ethyl alcohol which is saturated with urea at 100° F. (about 8% by weight) is disposed in the bowl 2 of filter 1, after being fed into it through pipe 5 while the filter is maintained at about 100° F. Filter drum 1, which is maintained about 30-40% submerged in the slurry mixture, is rotated in the direction of the arrow while a pressure differential is maintained through the filtering surface, causing the alcohol to flow through the filtering surface while urea crystals are deposited as a filter cake on the filter surface.

The urea crystals then come into contact with the waxy oil coming in through spray 18, and wax constituents of the oil, upon contacting the urea, enter into complex formation, forming a mass having good filtering qualities, which remains on the filter as the oil passes through. A spray of wash solvent discharged through nozzle 19 serves to wash the filter cake, which then is scraped from the drum, heated in heater 51 to decompose the complex, from which the alcohol-urea layer is separated in settler 53.

Another patent (2,606,214) issued to Standard Oil Co. (Ind.) discloses that petroleum oils often contain organic compounds which act as inhibitors in the formation of urea-hydrocarbon complexes. Among such inhibitors are the heteropolycyclic sulfur compounds, such as those present in low concentrations in West Texas virgin gas oil, Mid-Continent gas oil, and light catalytic cycle stock. The patent specifies that such inhibitors can be conveniently and effectively removed with an adsorbent such as activated alumina, or by acid treating.

It is pointed out that the reaction of urea with the purified charging stock is conveniently carried out by mixing solid urea, water, and purified charging stock, and agitating for at least 0.1 hr. at 15-35° C. The proportion of water to urea preferably is between 0.07-1.0% by weight. The decomposition is carried out by contacting the adduct with an additional amount of diluent or wash liquid (such as pentane) at 100-120° C.

Olefin-Sulfur Dioxide Resin That Is Thermally Stable

ONE of the cheapest resin materials probably would be the sulfur dioxide addition products of olefins, which are produced quite readily and simply. Unfortunately, however, such resins have been found to be thermally unstable at molding temperatures.

Phillips Petroleum Co. appears to have done considerable work, and has acquired a fair number of patents in this field. In its most recent patent (2,599,544) it describes the stabilization of such resins against thermal decomposition by incorporation of elemental sulfur or inorganic sulfides.

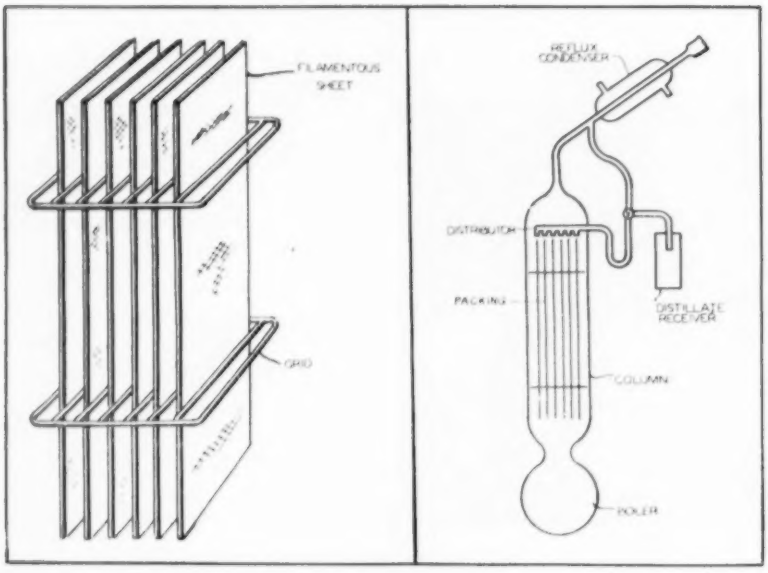
Examples given disclose, for example, that a sulfur dioxide resin prepared from commercial 1-butene shows a weight loss of 11.4% when heated for 3 hrs. at 325° F., whereas the same resin, latex coagulated with magnesium sulfate, and containing 2% by weight of sulfur, showed a loss of only 0.53% under such conditions. This development indicates that the defect of thermal instability of these resins can be overcome and, if such a result is achieved cheaply with small amounts of inhibitors which would not affect the general properties of the resin, a new class of plastics could become available from petroleum raw materials.

Aging Methyl Vinyl Ketone Improves Polymer Quality

THE poor physical properties of methyl vinyl ketone polymers are claimed to be due to the presence of vinyl acetylene, according to U. S. patent 2,599,616 issued to Celanese Corp. of America.

This is overcome by aging the methyl vinyl ketone at 0°-10° C. for at least 2 hrs., and preferably 3-10 hrs. after a distillation step in which the ketone is separated from inhibitors and similar materials.

The aging operation not only increases polymer yield and reduces polymerization time, but also gives clear, colorless, hard polymer, soluble in organic solvents and stable even at elevated temperatures.



Sheet Packing Increases Column Efficiency 44%

THE use of a filamentous sheet packing is proposed for distillation columns in Imperial Chemical Industries' patent 2,615,835. As can be seen in the left-hand drawing above, this packing consists of vertically stacked and spaced sheets of woven wire fitted into the column as shown at the right. An increase of some 44% in efficiency is obtained when means are provided in the column so that the liquid seals the filamentous openings in the sheets.

Patents Issued in November

The following classified listing gives the patent number, patentee or assignee, and a brief description of all patents believed to be of interest to the petroleum processing industries, as contained in the Official Gazettes of the U. S. Patent Office for November 4, 11, 18, *and* 25, 1952, *Vol.* 664, *Nos.* 1-4.

PROCESSES

Catalysts

2,616,857 (Houdry Process Corp.) Gel bead forming method and apparatus.
2,617,712 (Houdry Process Corp.) Potassium zeolites.
2,618,566 (Phillips Petroleum Co.) Magnesium aluminate pebble.
2,618,613 (Standard Oil Development Co.) Treatment of hydrocarbon conversion catalysts.
2,618,614 (Universal Oil Products Co.) Preparation of a copper-containing phosphoric acid catalyst.
2,618,615 (Standard Oil Development Co.) Forming silica-containing gel particles into strong tablets.
2,619,473 (Standard Oil Development Co.) Method and apparatus for regenerating a fluidized catalyst.
2,619,474 (Socony-Vacuum Oil Co.) Hydrous alumina catalyst support.

Conversions

2,616,836 (Standard Oil Development Co.) Removing aromatics from catalytic cracked cycle oil and re-cracking.
2,616,914 (Hydrocarbon Research Inc.) Process for catalytic conversion using fluidized bed.
2,616,934 (Universal Oil Products Co.) Hydrogen transfer process by reacting olefin in presence of SO_2.
2,617,708 (Shell Development Co.) Process and apparatus for contacting fluidized solids with gaseous fluids.
2,617,709 (Gulf Oil Corp.) Catalytic cracking process using suspended turbulent catalyst.
2,617,839 (The Texas Co.) Recovery and utilization of olefins from gases, using phosphoric acid catalyst.
2,618,974 (Shell Development Co.) Catalyst stripping and apparatus therefor.
2,618,534 (Sinclair Refining Co.) Alkylation reactor.
2,618,535 (Shell Development Co.) Apparatus for regenerating catalyst.
2,618,544 (Standard Oil Development Co.) Gasification of carbonaceous materials.
2,618,587 (Lummus Co.) Hydrocarbon conversion process and regeneration of fouled contact material utilizing flue gas and steam as the gas lift.
2,618,667 (Phillips Petroleum Co.) Catalytic dehydrogenation process.
2,618,669 (Sinclair Refining Co.) Two-stage alkylation process.
2,619,415 (Standard Oil Development Co.) Supply of heat to fluidized solids beds for the production of fuel gas.
2,619,449 (Standard Oil Development Co.) Method of catalyst production and utilization for high calorific fuel gas.
2,619,450 (Phillips Petroleum Co.) Hydrogenolysis process for the production of lower boiling hydrocarbons from heavy residual oils with reduced formation of coke.
2,619,451 (Standard Oil Development Co.) Transfer of heat to fluidized solids bed.
2,619,512 (Shell Development Co.) Olefin polymerization using phosphoric acid.

Hydrocarbon Synthesis

2,616,915 (The Texas Co.) Stabilization of fluidized iron synthesis catalyst.
2,617,774 (Ruhrchemie Aktiengesellschaft and Lurgi Gesellschaft fuer Waermetechnik) Preparation of an iron-silica gel Fisher-Tropsch catalyst.
2,617,816 (U. S. A.) Catalytic conversion of carbon monoxide and hydrogen to hydrocarbons and oxygenated organic compounds.
2,618,542 (M. W. Kellogg Co.) Manufacture of a gaseous mixture rich in hydrogen (and CO).
2,618,543 (Phillips Petroleum Co.) Production of carbon monoxide and hydrogen synthesis gas.
2,618,611 (Phillips Petroleum Co.) Production of hydrogen and carbon monoxide synthesis gas.

Refining

2,616,513 (Phillips Petroleum Co.) Portable amine gas treater.
2,616,514 (Phillips Petroleum Co.) Gas separation apparatus with liquid level controller.
2,616,515 and 521 (Union Oil Co. of Calif.) Adsorption process, using moving bed of solid granular adsorbent.
2,616,830 (M. W. Kellogg Co.) Refining of petrolatum with alcohol and aqueous alkali.
2,616,831 (Universal Oil Products Co.) Sweetening of hydrocarbon distillates by air blowing in presence of a phenylamine diamine and amine solvent.
2,616,832 (Standard Oil Development Co.) Sweetening of petroleum distillates with an alkali and an aldehyde, plus oxidation.
2,616,833 (Universal Oil Products Co.) Sweetening hydrocarbon distillates by caustic extraction in presence of a phenylene diamine.
2,616,834 (Sun Oil Co.) Removal of hydrogen sulfide compounds from mineral oil distillates by iron hydroxide suspension.
2,616,835 (Standard Oil Development Co.) Process for removing mercaptans from cat cracked naphtha by caustic washing second fraction and mixing with first.
2,616,912 (M. W. Kellogg Co.) Method of LPG solvent recovery.
2,617,272 (Petrocarbon Ltd.) Separation of gases at low temperature.
2,617,273 (Phillips Petroleum Co.) Continuous crystallization apparatus and process.
2,617,276 (Union Oil Co. of Calif. & Black, Sivalls and Bryson, Inc.) Separation of liquefiable hydrocarbons.
2,617,484 (Judson S. Swearingen) Treatment of gaseous mixtures for recovery of liquid hydrocarbons.
2,617,493 (Phillips Petroleum Co.) Separation of hydrocarbons from nonhydrocarbons by diffusion.
2,617,758 (Compagnie Francaise de Raffinage) Partial condensation of vapors.
2,617,815 (John J. Naugle) Method of refining wax using clay and alkaline earth oxide.
2,618,586 (Wigton-Abbott Corp.) Process for desulfurizing petroleum products in the liquid phase, using metal oxides.
2,619,280 (Shell Development Co.) Centrifugal contactor and method of contacting.
2,619,337 (Lummus Co.) Distillation column tray construction.
2,619,501 (Phillips Petroleum Co.) Process for decomposing urea adducts.

PRODUCTS

Chemicals

2,616,838 (M. W. Kellogg Co.) Distillation of nitriles.
2,616,863 (Universal Oil Products Co.) Styrenated drying oil compositions.
2,616,876 (Standard Oil Development Co.) Curing rubbery substances with meta-dinitroso aromatic compounds.
2,616,895 (M. W. Kellogg Co.) Oxidation of hydrocarbons, using copper oxide.
2,616,930 (Universal Oil Products Co.) Cycloalkyl aromatic ethers of polyalkylene glycols.
2,616,931 (Universal Oil Products Co.) Alkylation of p-alkoxyphenols.
2,616,933 (Universal Oil Products Co.) Hydration of olefins in presence of HF.
2,616,935 (Phillips Petroleum Co.) Deactivation of popcorn polymer with nitrtic acid.
2,617,149 (M. W. Kellogg Co.) Method of forming sheets from perfluorochlorocarbon plastic.
2,617,150 (M. W. Kellogg Co.) Compression molding of perfluorochlorocarbon plastics.
2,617,151 (M. W. Kellogg Co.) Injection molding of polytrifluorochloroethylene.
2,617,152 (M. W. Kellogg Co.) Transfer molding of perfluorochlorocarbon plastic.
2,617,599 (Shell Development Co.) Production of powdered capillary-active sulfuric acid derivative.
2,617,717 (Pure Oil Co.) Sulfur vaporizer.
2,617,718 (Jefferson Lake Sulphur Co.) Catalytic reactor.
2,617,756 (Stanolind Oil and Gas Co.) Process for recovery and purification of propionaldehyde.
2,617,757 (Stanolind Oil and Gas Co.) Azeotropic distillation of ketone-containing alcohols.
2,617,772 (Atlantic Refining Co.) Tack-free alkaryl sulfonate detergent.
2,617,781 (Chemstrand Corp.) Copolymers from quaternary salts of butene-1 derivatives.
2,617,800 (Phillips Petroleum Co.) Purification of carboxymethyl cellulose by ion exchange resins.
2,617,833 (Socony-Vacuum Oil Co.) Desulfurization of phenols.
2,617,834 (Atlantic Refining Co.) Hydration of olefins in liquid SO_2 using BF_3.

Patents

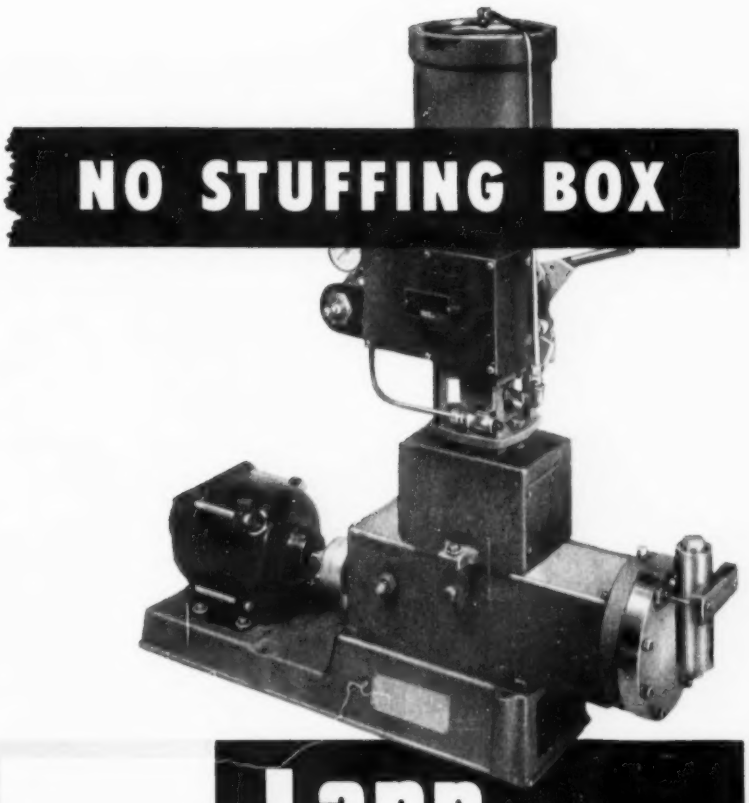
2,618,596 (Nuodex Products Co., Inc.) Oil soluble gelling agent.
2,618,616 (Shell Development Co.) Modified alkyd resins and compositions containing the same.
2,618,624 (Standard Oil Development Co.) Composition of styrene and isobutylene polymers.
2,618,626 (Shell Development Co.) Process of polymerizing olefinically unsaturated compounds.
2,618,649 (Shell Development Co.) Production of esters of products from oxo synthesis.
2,618,650 (Ethyl Corp.) Manufacture of amyl nitrate.
2,618,652 (Standard Oil Development Co.) Process for the purification of acrylate and methacrylate esters.
2,618,662 (Phillips Petroleum Co.) Production of naphthene hydroperoxides.
2,618,664-6 (The Texas Co.) Process for isolating phenolic compounds from mixtures thereof.
2,619,466 (Monsanto Chemical Co.) Mercaptan-ethylene oxide condensation products of reduced pour point.
2,619,477 (Standard Oil Development Co.) Copolymers of dimethyl itaconate and conjugated diolefins.
2,619,481 (Standard Oil Development Co.) Curing rubbery olefinic copolymers.
2,619,491 (Shell Development Co.) Tetrahydropyranyl ethers.
2,619,497 (Standard Oil Development Co.) Recovery of high boiling alcohols by activated alumina.
2,619,510 (Hercules Powder Co.) Manufacture of isopropyl benzene hydroperoxide.
2,619,511 (Richard Conrad) Production of unsaturated hydrocarbons by reacting olefin with ether and splitting off water.

Fuels

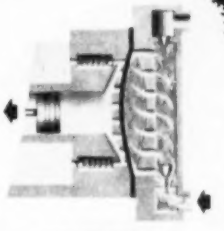
2,618,536 (Sherwin-Williams Co.) Gel-type fuel.
2,618,538 (Standard Oil Development Co.) Diesel fuel containing dinitro cyclohexyl peroxide.
2,618,612 (Standard Oil Development Co.) Concentrated lead fluids.
2,619,496 (Robert Stanton) Solid-liquid reaction processes in lead alkyl production.

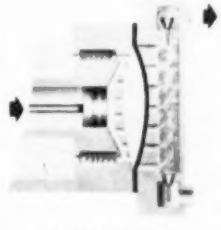
Lubricants

2,616,849 (Socony-Vacuum Oil Co.) Copolymers of maleic anhydride with esters of itaconic acid and salts thereof as viscosity index improvers and pour point depressants.
2,616,850 (Standard Oil Co.-Indiana) Grease preparation using solvent removal.
2,616,851 (Socony-Vacuum Oil Co.) Mineral oil composition containing esters of product obtained by reaction between maleic anhydride and vinyl acetate.
2,616,852 (Socony-Vacuum Oil Co.) Mineral oil composition containing allyl ester reaction product.
2,616,853 (Socony-Vacuum Oil Co.) Mineral oil composition containing alcohol and amine derivatives of maleic anhydride-itaconic acid ester copolymers as pour point depressants and viscosity index improvers.
2,616,854 (U.S.A.) Hydraulic fluid containing isoparaffins and olefin and acrylic ester polymers.
2,616,904-6 (Lubrizol Corp.) Organic alkaline earth metal complex and method of making same.
2,616,911 (Lubrizol Corp.) Organic alkaline earth metal complexes formed by use of sulfonic promoters.
2,616,916 (Standard Oil Development Co.) Preparation of olefin lubricant having a high viscosity by oxidation in presence of diphenyl thiourea.
2,616,924 (Lubrizol Corp.) Organic alkaline earth metal complexes and method of making same.
2,616,925 (Lubrizol Corp.) Organic alkaline earth metal complexes formed by use of thiophosphoric promoters.
2,617,768 (Shell Development Co.) Marine engine lubricant containing sulfonates.
2,617,769 (Socony-Vacuum Oil Co.) Soluble rolling oil composition.
2,618,597 (Standard Oil Development Co.) Oxidation resisting hydrocarbon products containing cuprous di(methyl-cyclohexyl) dithiophosphate.
2,618,598 (Standard Oil Development Co.) High-temperature lubricating grease containing soap of this acid.
2,618,599 (Standard Oil Development Co.) High melting point calcium grease of low soap content.
2,618,600 (Douglas Aircraft Co.) Silicone oil lubricating composition.
2,618,601 (Douglas Aircraft Co.) Lubricant containing a dimethyl silicone polymer and a trialkyl phosphate.



Lapp
Auto-Pneumatic
PULSAFEEDER


INTAKE STROKE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No packing or other leak-likely gland can be in contact with chemical being handled by the Lapp Pulsafeeder. A hydraulically-balanced diaphragm acts as a floating partition, without mechanical load or pressure differential—assures isolation of chemicals being pumped from all working pump parts. Pumps against pressures to 2,000 lbs., at constant pumping speed—variable flow for continuous processing results from variation in piston-stroke length-controlled by instrument air pressure responding to any instrument-measurable processing variable.

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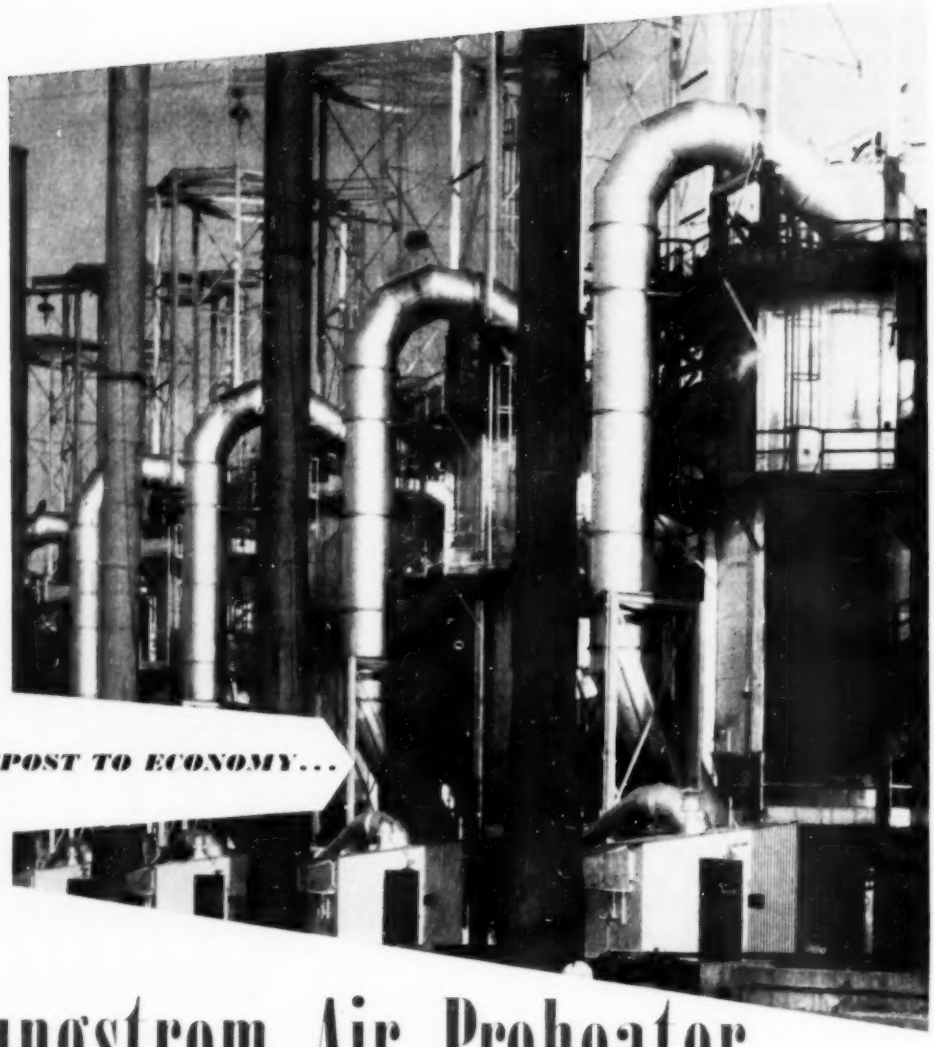
(To obtain more data on advertised products see page 128)



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Wherever You Burn Fuel, You Need Ljungstrom

THE AIR PREHEATER CORPORATION

60 East 42nd Street, New York 17, N. Y.

(To obtain more data on advertised products see page 128)

2,618,602 (Standard Oil Development Co.) Lubricating composition of low pour point containing polymerized fumaroid ester.
2,619,458 (Westinghouse Electric Corp.) Compositions embodying solid lubricants containing molybdenum disulfide.
2,619,459 (Union Oil Co. of Calif.) Lubricating oil composition containing sulfonate-phenol product.
2,619,460 (Union Oil Co. of Calif.) Lubricating oil composition containing sulfonate-aldehyde product.
2,619,461 (Phillips Petroleum Co.) Lubricating grease with controlled fiber length.
2,619,462 (Sinclair Refining Co.) E. P. mineral oil compositions.
2,619,463 (Esso Standard Societe Anonyme Francaise) Extreme pressure lubricant.
2,619,464 (Socony-Vacuum Oil Co.) Lubricant containing high molecular weight alkyl monothiocyanates.
2,619,465 (Standard Oil Co.) Stabilized hydrocarbon oils and waxes containing methyl phytyl naphthohydroquinone.

Specialties

2,616,794-5 (Phillips Petroleum Co.) Carbon black process.
2,616,837 (Standard Oil Development Co.) Air-blowing asphalt in presence of methylpolysiloxane to increase flash point.
2,617,714 (Phillips Petroleum Co.) Process for producing carbon black.
2,618,384 (Pure Oil Co.) Packaging of oil-soluble dyes in oil-soluble capsules.
2,618,533 (Union Oil Co. of Calif.) Manufacture of carbon black.
2,618,582 (Union Oil Co. of Calif.) Pest control with diphenyl disulfoxide.
2,619,403 (Celanese Corp. of America) Emulsified volatile hydrocarbon liquids as printing paste thickeners.
2,619,416 (International Carbon-Black Corp.) Apparatus for explosive conversion of hydrocarbon gases to carbon black.

Miscellaneous

2,617,302 (Compagnie Francaise de Raffinage) Device for gauging the water level in the bottom of hydrocarbon tanks and the like.
2,617,304 (Socony-Vacuum Oil Co.) Pressure measuring instrument.
2,617,305 (Socony-Vacuum Oil Co.) Barometer preheater.
2,617,587 (Phillips Petroleum Co.) Computer component.
2,617,713 (Pure Oil Co.) Method of inhibiting corrosion of steel by alkali solutions containing thiosulfate.
2,617,716 (Stanolind Oil and Gas Co.) Combustible gas analyzing apparatus.
2,618,588 (Standard Oil Development Co.) Fluidized shale distillation.
2,618,589 (Standard Oil Development Co.) Continuous retorting of oil shale.
2,618,974 (Standard Oil Development Co.) Fluid flow gauge.
2,618,978 (Standard Oil Development Co.) Pressure gauge attaching device for portable service.
2,619,408 (Arthur C. Mengel) Method of testing lubricating oil.

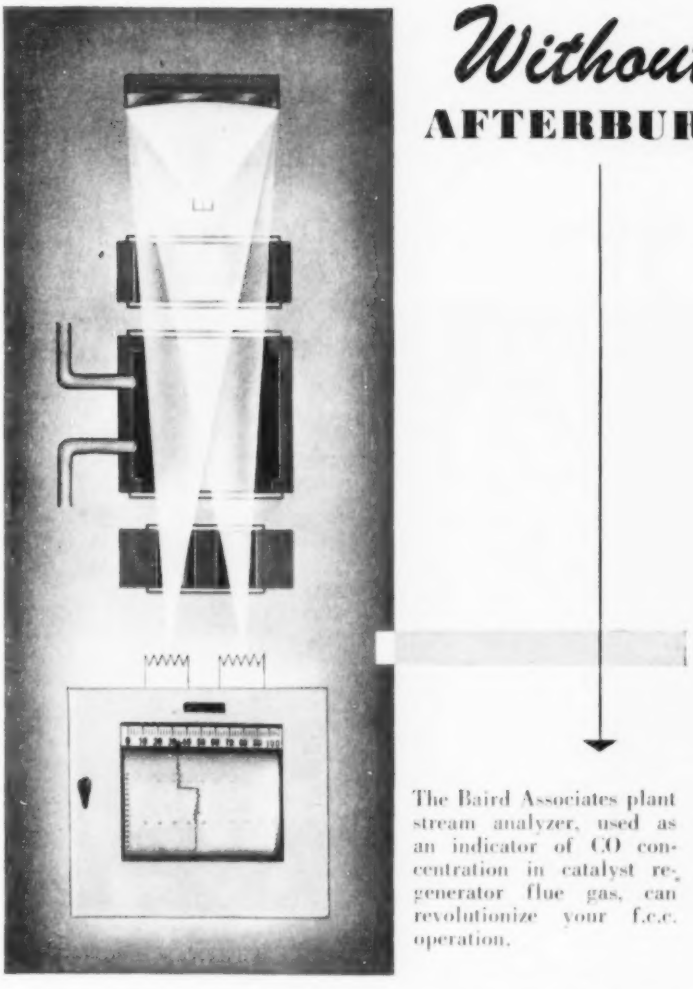
EQUIPMENT

Processing, general

2,616,513 (Phillips Petroleum Co.) Portable amine gas treater.
2,616,514 (Phillips Petroleum Co.) Gas separation apparatus with liquid level controller.
2,616,619 (Norman A. MacLeod) Apparatus and method for centrifugal elutriation.
2,616,620 (Merco Centrifugal Co.) Centrifuge.
2,616,621 (De Laval Separator Co.) Valve system for centrifuges.
2,616,829 (Union Oil Co. of California) Absorption apparatus and process.
2,617,273 (Phillips Petroleum Co.) Continuous crystallization apparatus and process.
2,617,717 (Pure Oil Co.) Sulfur recovery apparatus.
2,617,760 (Metropolitan-Vickers Electrical Co. Ltd., London, England) Short path fractionating centrifugal still.
2,618,534 (Sinclair Refining Co.) Alkylation reactor.
2,618,668 (The Lummus Co.) Control for a cracking heater.
2,619,077 (The Lummus Co.) Tube support for heaters.
2,619,187 (Black, Sivalls & Bryson, Inc.) Gas and liquid separator.
2,619,280 (Shell Development Co.) Centrifugal contactor and method.

FOR OUTPUT BEYOND RATED CAPACITY

Without AFTERBURN



The Baird Associates plant stream analyzer, used as an indicator of CO concentration in catalyst regenerator flue gas, can revolutionize your f.c.c. operation.

The start of afterburning is revealed so quickly that the afterburn can be quenched at once by the lean-phase water sprays.

This means that there is no loss of production, and no risk of damage to the regenerator.

This means that enormously increased conversion rates can be reached — without impairing catalyst life.

This means that the huge production demanded today can be safely met — by plants that use infrared analysis in controlling regenerator operation.

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(*To obtain more data on advertised products see page* 128)

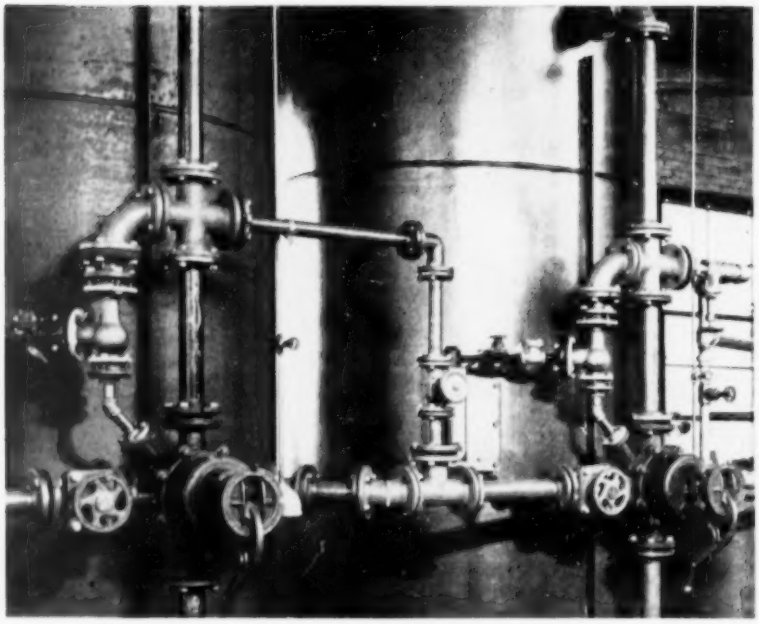
DOW

CUT CORROSION COSTS

install corrosion-resistant

SARAN LINED STEEL PIPE

for long, trouble-free service



Saran Lined Pipe, Fittings and Valves are used in this automatic water deionizer in a large water purification system. Installations such as this give trouble-free service for many years.

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Corrosion-resistant Saran Lined Steel Pipe sharply reduces repair and maintenance costs in corrosive piping installations. Downtime is cut to a minimum because this rigid pipe has high pressure strength and durability—which mean dependable, long-term service. Easily installed Saran Lined Steel Pipe can be cut and threaded in the field—no need for special tools or handling. Wherever superior resistance to most chemicals and solvents is demanded, be sure to consider Saran Lined Pipe, Fittings and Valves. Write to the distributor: SARAN LINED PIPE COMPANY, 2415 Burdette Avenue, Ferndale, Michigan. Offices in: New York • Boston Pittsburgh • Tulsa • Philadelphia Chicago • Portland • Indianapolis San Francisco • Houston • Denver Los Angeles • Seattle • Cleveland Charleston, S. C. • Toronto • Montreal. Clip and send today!

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DOW

Patents

2,619,336 (Air Products, Inc.) Gas separation bubble plate.
2,619,337 (The Lummus Co.) Distillation column tray construction.
2,619,410 (International Carbon-Black Corp. Ltd., Vaduz, Liechtenstein) Apparatus for explosive conversion of hydrocarbon gases to carbon black.

Catalytic Reactors

2,617,708 (Shell Development Co.) Apparatus and process for contacting fluidized solids with gaseous fluids.
2,617,718 (Jefferson Lake Sulphur Co.) Catalytic reactor.
2,618,074 (Shell Development Co.) Catalyst stripper.
2,618,535 (Shell Development Co.) Apparatus for continuously removing combustible deposits from finely divided solids.
2,619,473 (Standard Oil Development Co.) Apparatus and method for regenerating a fluidized catalyst.

Valves & Fittings

2,616,255 (Allis-Chalmers Mfg. Co.) Compensated expansion joint.
2,616,447 (P. H. Williams) Boiler feed regulator.
2,616,448 (Conoflow Corp.) Control valve actuator.
2,616,653 (Phillips Petroleum Co.) Positive shutoff valve.
2,616,655 (P. A. Dewhirst; L. S. Hamer) Gate valve.
2,616,656 (C. A. Crawford) Fluid control valve.
2,616,657 (American Car & Foundry Co.) Lubricated plug valve.
2,618,457 (Taylor Instrument Cos.) Needle valve.
2,619,110 (D. G. Griswold) Pilot-controlled gate and by-pass valve.
2,619,113 (Black, Sivalls & Bryson, Inc.) Valve for relieving high and low pressures.
2,619,114 (Wallace & Tiernan Co, Inc.) Gas flow control valve.
2,619,115 (J. A. Dondero & P. Wisser) Spring biased relief valve.

Instruments

2,616,294 (Claude A. Pickens) Filtering liquid level gage.
2,616,296 (Minneapolis-Honeywell Regulator Co.) Absolute temperature ratio measuring device.
2,616,297 (W. C. Dillon & Co. Inc.) Thermometer.
2,617,300 (Yarnall-Waring Co.) Flow meter.
2,617,301 (Vincent Gentile, Jr.) Flow tube differential pressure producer.
2,617,302 (Compagnie Francaise de Raffinage (Societe Anonyme, (Paris, France) Device for gaging the water level in the bottom of hydrocarbon tanks.
2,617,441 (Yarnall-Waring Co.) Liquid level alarm.
2,617,587 (Phillips Petroleum Co.) Computer component, a recorder for obtaining a graphic representation of x as a function of y.
2,617,716 (Stanolind Oil & Gas Co.) Combustible gas analyzer.
2,618,245 (H. E. Phillips, Streatham Vale, London, England) Liquid flow meter.
2,618,286 (Fisher Governor Co.) Pneumatic reverse acting relay.
2,618,287 (W. W. Taylor) Differential pressure responsive control.
2,618,288 (The Foxboro Co.) Nozzle-flapper action device for pneumatic instruments.
2,618,294 (The Foxboro Co.) Pneumatic flow control unit.
2,618,528 (Minneapolis-Honeywell Regulator Co.) Chart drive mechanism.
2,618,974 (Standard Oil Development Co.) Fluid flow meter of variable area type.
2,618,975 (The Weatherhead Co.) Rotary liquid level gage.
2,618,978 (Standard Oil Development Co.) Pressure gage attaching device for portable service.
2,619,409 (Union Carbide & Carbon Corp.) Apparatus for measuring the combustible content of a gas.
2,619,566 (C. F. Mahoney) Actuating apparatus responsive to change in liquid level.
2,619,567 (Fenwal Inc.) Thermostatic switch.

Pumps & Compressors

2,616,614 (Ingersoll-Rand Co.) Steam ejector or thermocompressor.
2,616,615 (De Laval Separator Co.) Oil-less vacuum pump of the positive displacement type.
2,616,616 (Charles J. Wolff) Positive displacement rotary pump and compressor.
2,619,292 (du Pont Co.) Positive displacement type, rotary, slurry pump with screened discharge for preventing lump accumulation.

All SHELL AND TUBE ...HEAT EXCHANGERS by Vogt

ABOVE: View of new construction at Louisville Refining Company.

BELOW: Some of the many Shell and Tube Exchangers.

Engineered and Licensed by
UNIVERSAL OIL PRODUCTS CO.

At LOUISVILLE REFINING CO.'S New CATALYTIC CRACKING PLANT

Premium gasoline production has been boosted 20% from the same amount of oil charged since the Louisville Refining Company's new Catalytic Cracking Plant went on stream.

The new plant uses Vogt Shell and Tube Heat Exchangers exclusively and they make a significant contribution to the efficient and economic operations of this progressively modern refinery.

Vogt Shell and Tube Heat Exchangers are available in many different types, with fixed or removable tube bundles, to meet the special problem and specific operating conditions of each installation. They are constructed from carbon and special steels to meet every temperature, pressure, or vacuum service requirement.

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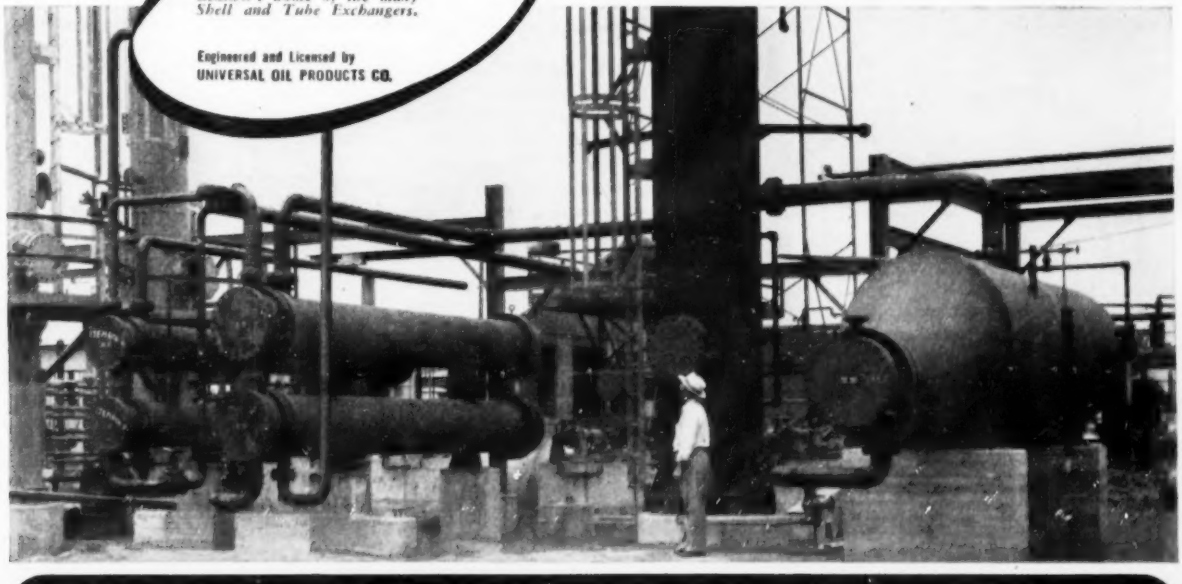


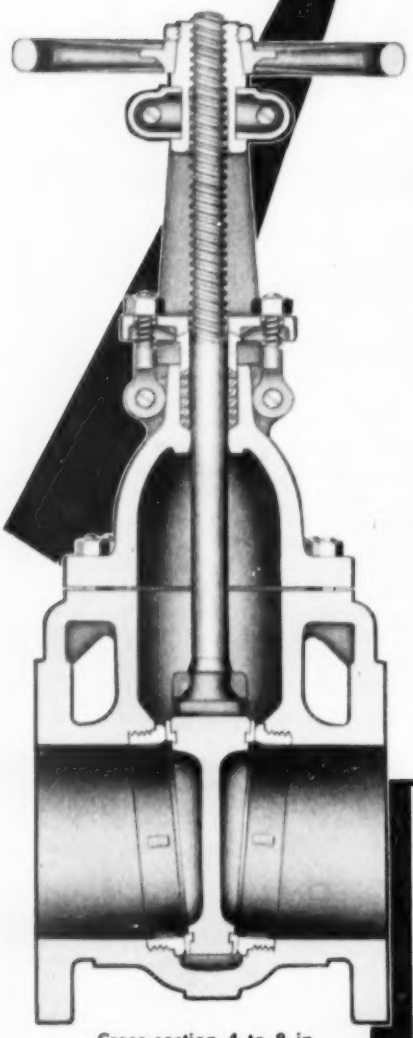
HENRY VOGT MACHINE CO. Louisville 10, Ky. • BRANCH OFFICES: NEW YORK, PHILADELPHIA, CHICAGO, CLEVELAND, ST. LOUIS, DALLAS, CHARLESTON, W. VA.

cut the high cost of corrosion

IN MANY SERVICES...WITH

CRANE *Ni-Resist*

CAST IRON GATE VALVES



Cross-section 4 to 8 in. sizes; bolted bonnet joint; flanged ends.

Here is a line of "cast iron" gate valves with a special talent for resisting corrosion, erosion and wear. Use them with safety where the strength of ordinary cast iron is adequate—in soda and sulfate pulp mill service—on creosote lines in wood treating processes—for handling sour distillates and crudes in petroleum refining—and many similar services.

Clue to the extra staying-power of Crane Ni-Resist Cast Iron Valves is in their make-up (approximately 14% nickel, 2½% chromium, and 6% copper)—and in their 18-8 Mo Alloy Steel stem and seating faces. Not to be overlooked is the fine Crane design that gives you a strong body and bonnet without excessive weight, a well-proportioned stem with precision-cut threads, a sturdy yoke, and the dependable disc-stem connection that assures smooth operation and tight seating of the solid wedge disc. Ask your Crane representative for full details, or see your Crane Catalog.

THE CRANE NI-RESIST LINE

Working Pressures:
Cold Water, Oil, or Gas, Non-shock
Screwed Valves—225 pounds
Flanged Valves—200 pounds

Available in sizes ½ to 8 in. All have solid wedge disc, with outside screw and yoke. Sizes ½ to 3 in. have clamp type bonnet joint and one-piece bolted gland. Sizes 4 to 8 in. have conventional bolted bonnet joint and two-piece bolted gland.

No. 1671 with Bolted Bonnet Joint, Flanged ends only. Sizes 4, 6 and 8 in.

No. 1670 with Clamp Type Bonnet Joint with screwed ends. Sizes ½ to 2 in. Also with flanged ends 1 to 3 in.

***The Complete Crane Line Meets All Valve Needs. That's Why* More Crane Valves Are Used Than Any Other Make!**

CRANE VALVES

CRANE CO., *General Offices:* 836 S. Michigan Ave., Chicago 5, Illinois
Branches and Wholesalers Serving All Industrial Areas

VALVES • FITTINGS • PIPE • PLUMBING • HEATING

PERSONALS

Dr. Carl O. Tongberg has been appointed director of the Research Division of Esso Laboratories of Standard Oil Development Co. **Dr. Charles L. Fleming, Jr.,** is made associate director and **Gordon W. Duncan** becomes an assistant director. Two new section heads have been named in the Research Division. **Dr. Joseph P. Hamer** heads the Automotive Fuels and Lubricants Section and **Elfried F. E. Pennekamp** the Additives Section. **George S. Tobias** is aviation contact representative.

Dr. Tongberg

Dr. Fleming

Mr. Duncan

Dr. Tongberg received his BS and MS degrees in chemistry from Harvard and his doctorate in the same subject from Pennsylvania State College. He joined the Esso Laboratories in 1937 and holds several patents in the field of hydrocarbon conversions

Dr. Fleming received his AB degree from Dartmouth and his doctorate in chemistry from the University of Illinois. He joined Esso Laboratories in 1938 and served as advisor to Esso European Laboratories from 1947 to 1948. Mr. Duncan received his BS and MS degrees from Pennsylvania State College and joined Esso Laboratories in 1937. He has been issued several patents in solvent extraction, rust preventives, fuels, lubricants and greases.

Dr. Hamer received his BS from the University of Maryland and his MS and his PhD in chemistry from Pennsylvania State College. He joined Esso Laboratories in 1947. Mr. Pennekamp received his MS degree from the University of Tennessee and became associated with Esso Laboratories in 1943. Mr. Tobias joined Esso Laboratories in 1946 after receiving BS degrees in chemical Engineering at Ohio State University.

Dr. Robert W. Cairns, assistant research director for Hercules Powder Co., Wilmington, Del., has been named vice-chairman of the Research and Development Board, a staff agency of the Secretary of Defense. He will be on loan for a year, serving without compensation.

Dr. Cairns has been assistant director of the research department since 1945 and was cited for his work on propellants and explosives with the National Defense Research Committee during 1944-45 by both the War and Navy departments in World War II. In his new post, he will devote full time to problems of national defense, the same type of problems he has been involved in part-time since 1941.

* * *

R. A. Lindsay is manager of the heavy industries section of Technical Service and Development of Dow Chemical Co. He will be responsible for the development of chemicals for the petroleum, chemical and other industries. He was formerly section head of chemical engineering products, Organic Chemical Sales. He received his MS in Chemical Engineering from the University of Michigan in 1940 and joined Dow's Consulting Engineering Division in 1941.

* * *

Howard G. Vesper has been elected a vice president of Standard Oil Co. of Calif. in addition to his present duties as president of California Research Corp., Standard's research subsidiary. He joined Standard in 1922 with the research and development department of the El Segundo refinery, then worked as a salesman in the foreign trade operations at New York. Returning to the manufacturing department, he was manager of gasoline and fuel oil marketing until elevated to the presidency of Cal Research in 1946.

Mr. Vesper

* * *

Charles R. Stevenson retired Dec. 31 as assistant treasurer of Gulf Oil Corp. and plant manager of its Port Arthur, Texas, refinery, after more than 50 years of service with the company, all at the Port Arthur plant. Mr. Stevenson was born in a sod house in Nebraska in 1887, his family settling in Port Arthur in 1897. When he was 15 he got a job as office boy with the then young Gulf company. He became assistant to the purchasing agent, then purchasing agent in 1909 and in 1929 was made plant manager of the three refineries in Texas. He was elected an assistant treasurer of Gulf Oil Corp. in 1938.

* * *

G. William Hardell has been appointed vice-president and manager of manufacturing for Sinclair Chemicals, Inc. He formerly was general superintenent of Sinclair Rubber, Inc. Both companies are subsidiaries of Sinclair Oil Corp.

Mr. Hardell

Also named to new posts with Sinclair Chemicals were: **Dr. Robert R. Chambers** as director of research and **Robert A. Wiegand,** secretary and administrative assistant to the executive vice-president.

Dr. Chambers

Mr. Wiegand

* * *

Three members of Esso Standard Oil Co.'s Bayway (N.J.) refinery technical department have been given assignments with foreign affiliates on a loan basis.

Dr. Francis M. Archibald, head of the laboratories division, and **Robert J. Anderson,** head of the budget sections, economic planning division, on loan to Standard Vacuum Oil Co.'s Durban, South Africa, refinery; the former beginning Feb. 1 as technical consultant to the management and the latter beginning Jan. 1 as head of process and mechanical engineering and equipment-inspection activities.

C. Russell Haag, now assistant head of the process engineering division, on Jan. 1 was loaned for three months to the Esso Aktiengesellschaft at Hamburg, Germany, to organize the technical activities at the

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● The object of all McKee refinery engineering is to provide facilities of such design as to obtain fullest advantage from the process involved. In a word, to get the *greatest yield of highest quality product at lowest cost.*

McKee Company's enlarged process engineering facilities, design, engineering, procurement and construction services are backed by a long, successful record of attaining this objective for refiners in every quarter of the globe.

These services are available to you to any extent you require them—from consultation to a turnkey job on a complete refinery.

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District Engineering Offices: Union, New Jersey and Tulsa, Oklahoma.

expanded refinery now under construction there.

A number of shifts in the technical department have occurred to free these three men for their loan assignments. These include: **Rea E. Kreider** to acting head, process engineering division; **J. E. Connor** to head of the budget section economics and planning division; **H. T. Rice** to head of cost analysis division; **Helmuth G. Schneider** to head of the chemical products laboratory (as well as present duties as head of the Paratone laboratory); **Robert S. Smith,** head of economics section, economics and planning division; **Bernard C. Ryan** to head of the planning section, economics and planning division; **Alfred H. Connellee** to head of the design engineering section, process engineering division, and **Roosevelt L. Clark** to head of the design group, process engineering division.

* * *

Dr. M. E. Spaght has been appointed to the newly-created executive vice-presidency of Shell Oil Co. As president of Shell Development Co., Dr. Spaght has been in charge of Shell research in the U. S., joining the company in 1933 as a chemist.

Dr. Spaght

Dr. Gershinowitz

Dr. Harold Gershinowitz, a Shell vice-president and head of exploration and production research in Houston, has been appointed president of Shell Development to replace Dr. Spaght. Well known in scientific circles, he has been with Shell since 1938.

* * *

Clarke C. Miller is information coordinator at the Whiting, Ind., research laboratories of Standard Oil Co. (Indiana). He joined Standard as a chemical engineer in 1924 after graduating from MIT, and from 1935-45 was chief chemist at the Wood River, Ill., laboratory. He was then in charge of technical-information activities at Whiting.

Harry L. Hilleary, graduate of Cornell University, is group leader at the Wood River laboratory. He joined Standard in 1947. **Max D. Napper** is group leader at the Casper, Wyo., laboratory. He joined Standard in 1935 after graduating from University of Wyoming.

* * *

Dr. D. M. Morrison, M.B.E., has been appointed manufacturing manager of Shell Oil Co. of Canada, Ltd., as soon as he returns from his post as director of the petroleum division, Dept. of Defense Production, for the Canadian government. In his new post, Dr. Morrison will direct all Shell's refining and petrochemical operations in Canada from his Toronto headquarters. He was formerly manager of the Montreal East refinery and directed its post-war expansion.

Dr. Morrison

* * *

Robert V. Kerley, associate director of research for Ethyl Corp. Laboratories, Detroit, has been elected chairman of the Aviation Technical Service Committee of the API Division of Marketing for 1953. He succeeds **Warren L. Baker,** who recently retired as manager of the Aviation Department of Socony-Vacuum Oil Co. in New York. **D. H. Young,** manager of the Aviation Department of Pure Oil Co., Chicago, was named vice-chairman, succeeding **T. S. Blair,** New York, manager of aviation sales and engineering, Petroleum Adviser, Inc.

Kerley graduated in mechanical engineering at Oregon State College, was with the U. S. Air Force at Wright Field, Dayton, in civilian capacities and joined Ethyl Corp. in 1945.

* * *

Thomas Baron, Shell Development Co., Emeryville, Cal., has been jointly chosen with **Lloyd G. Alexander,** Oak Ridge National Laboratory, to receive the 1952 Junior Award in chemical engineering of the American Institute of Chemical Engineers. The two collaborated in a study entitled "Momentum, Mass and Heat Transfer" judged most outstanding of those published by Junior members of the Institute over the past three years.

Mr. Baron

Baron, a native of Hungary, received his BS and PhD in chemical engineering from the University of Illinois. He was an instructor and

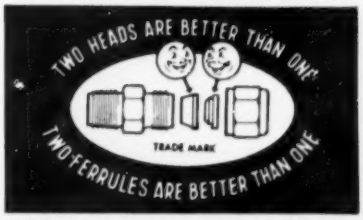
Standard Swagelok Tube Fittings in fractional sizes are now available for holding thermocouples.

Thermocouples or dip tubes are easily handled with these new Swagelok Connectors. They can be furnished in a wide variety of sizes from 1/8" up in brass, aluminum, steel, stainless steel and Monel.

Latest catalog showing complete line of Swagelok Fittings will be sent on your request to Dept. 64.

CRAWFORD FITTING CO.
884 E. 140th Street, Cleveland 10, Ohio

SWAGELOK FITTINGS AVAILABLE IN: BRASS, ALUMINUM, STEEL, STAINLESS STEEL, MONEL



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(To obtain more data on advertised products see page 128)

ON-STREAM!

On-time - - - On-budget

This $10,000,000 refinery modernization project for Standard Oil of Texas at El Paso was completed five days ahead of schedule—despite the steel strike. It was completed within the budget—despite cost increases in material and labor.

Catalytic's undivided responsibility covered engineering, procurement and construction—and accomplished the field work in ten months from date of installation of construction facilities.

CATALYTIC ON-TIME . . . ON-BUDGET SERVICES

for the chemical, petrochemical and oil refining industries

Project Analysis Engineering Economic Studies

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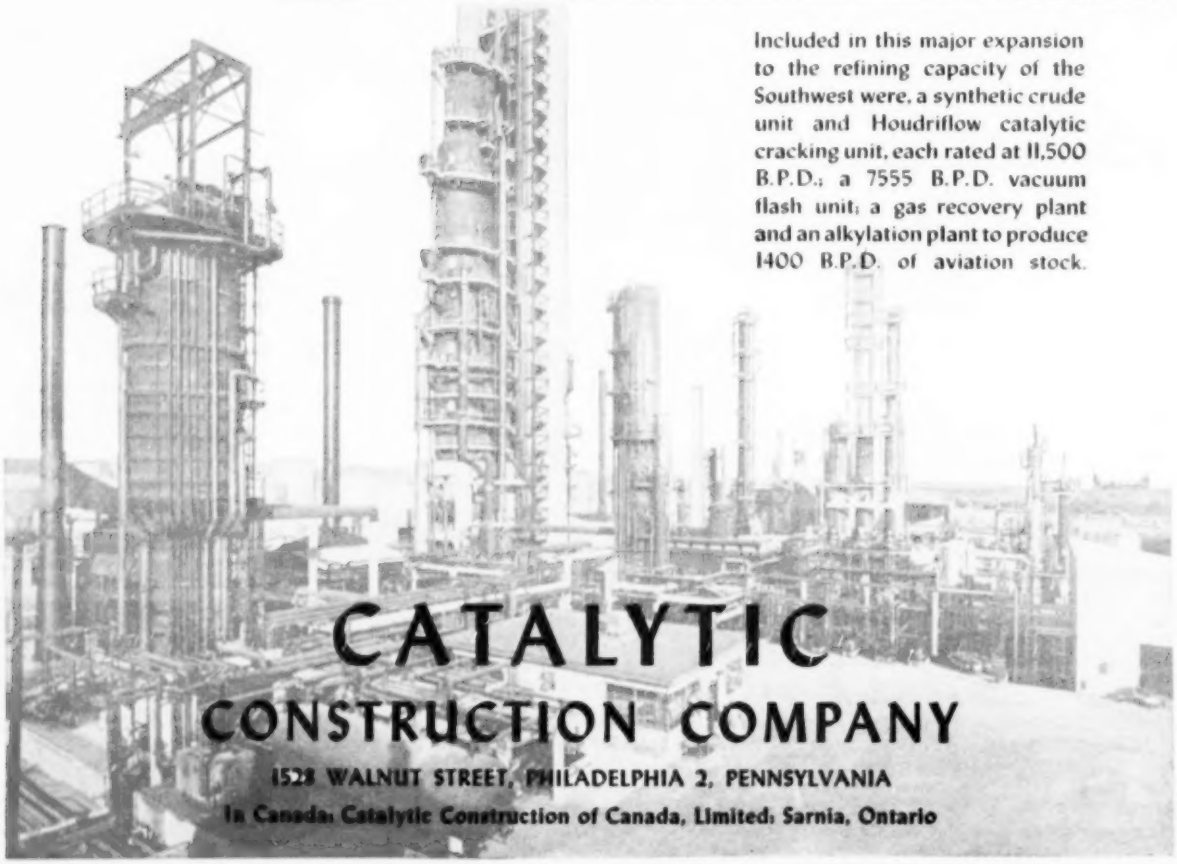

Included in this major expansion to the refining capacity of the Southwest were, a synthetic crude unit and Houdriflow catalytic cracking unit, each rated at 11,500 B.P.D.; a 7555 B.P.D. vacuum flash unit; a gas recovery plant and an alkylation plant to produce 1400 B.P.D. of aviation stock.

CATALYTIC
CONSTRUCTION COMPANY

1528 WALNUT STREET, PHILADELPHIA 2, PENNSYLVANIA

In Canada: Catalytic Construction of Canada, Limited: Sarnia, Ontario

(*To obtain more data on advertised products see page* 128)

assistant professor at Illinois. While so engaged he became consultant to the Army Chemical Corps and in 1951 he joined Shell Development Co.

* * *

Mr. Lyman

Mr. Batchelder

A. L. Lyman has been elected to the newly-created position of executive vice president of California Research Corp., Standard of California subsidiary, of which he has been a director since 1944.

A. H. Batchelder, assistant laboratories director, was elected vice president and director. He will be general manager of Cal Research laboratories, Richmond, Calif., succeeding Mr. Lyman.

Mr. Lyman joined Standard in 1924 following his graduation from the University of California, became lab manager in 1938 and was made a director of the new subsidiary when it was formed in 1944. He is national chairman of the petroleum division of American Chemical Society for 1953 and a member of Alpha Chi Sigma, professional chemical fraternity.

Mr. Batchelder started with Standard in 1930 and has been assistant director of Richmond laboratories since 1946. He is known for his publications and patents in fields of asphalts, fuel oils, lubricants, resins and drying oils.

* * *

Dr. Floyd L. Miller has been appointed manager of the contract, legal and patent department, Standard Oil Development Co., upon his return from a year's loan to the Research and Development Board, Dept. of Defense, where he served as vice-chairman. Prior to his Washington assignment, Dr. Miller headed SOD's research division.

* * *

The Department of the Interior has conferred posthumously its highest award for distinguished service in the name of **Nicholas A. C. Smith,** who for 19 years was superintendent of the Petroleum Experiment Station of the Bureau of Mines in Bartlesville, and had served the government almost 37 years to his death in 1952. The citation points out that Mr. Smith was a pioneer in developing methods of analytical distillation of petroleum and its products, and in interpreting crude oil analyses and that he aided greatly to the fund of human knowledge regarding the chemistry of petroleum.

* * *

Bruce E. Boswell, engineer in the products application section of Shell Oil Co.'s manufacturing department, San Francisco, has been transferred to the Martinez research laboratory.

* * *

Paul E. Kuhl, assistant general manager of manufacturing for Esso Standard Oil Co., New York, will join PAD in Washington as deputy director of the foreign refining division. He will later replace **Vaughan W. Ilschie,** Sinclair Refining Co., as head of the division.

* * *

R. J. S. Pigott retired from his position as Director of Engineering, Gulf Research & Development Co., on Jan. 1 but will continue in the capacity of consultant. Since graduating from Columbia in Mechanical Engineering in 1906, he has achieved a notable record in the engineering field, having served as president of the American Society of Mechanical Engineers, of the Instrument Society of America, of the American Society for Measurement and Control and of the Society of Automotive Engineers. He holds many patents on engineering devices

Mr. Pigott

Mr. Pigott was professor of Steam Engineering at Columbia from 1912-13, and after wide engineering experience joined Gulf Research as Director of Engineering Research in 1929.

* * *

John C. Sample, director of General Petroleum Corp., Los Angeles, has been elected vice president and will co-ordinate manufacturing, pipeline and supply activities.

* * *

Chester L. Babin, manager of Creole Petroleum Corp.'s refinery in Amuay, Western Venezuela, retired Jan. 1 after 33 years' service in the U. S., Colombia and Venezuela. Succeeding him will be **Calvin Cooper,** who has been assistant manager at Amuay.

* * *

F. K. Davis, who was operations superintendent in Amuay, will become assistant manager and, in turn, **Montague Ball** will become operations superintendent by transfer from his job as coordinator at the Caripito, Eastern Venezuela, refinery.

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MERCURY ACTUATED

Temperature Indicating Instruments

4½" DIAL THERMOMETERS

Made in 3 types to suit any requirements. Rigid stem, wall or flush mounted, 11 inches of scale reading. Interchangeable with standard industrial separable sockets. Stem can be placed at any angle and case can be rotated to any readable position.

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Twelve inch die-cast aluminum case with black or white wrinkle or satin finish. Single or multiple pen construction. Electric or spring wound clock, 24 hour or 7 Day Revolution. Flexible Armor and bulb of stainless steel. Ranges —40 +950°F or Equivalent in °C.

INDUSTRIAL THERMOMETERS

Red-Reading Mercury —Extruded brass case — chrome finish. Ranges —40 + 950°F or Equivalent in °C.

RED-READING MERCURY LABORATORY THERMOMETERS

Thoroughly annealed for permanent accuracy. Complete line A.S.T.M. and fractional division types.

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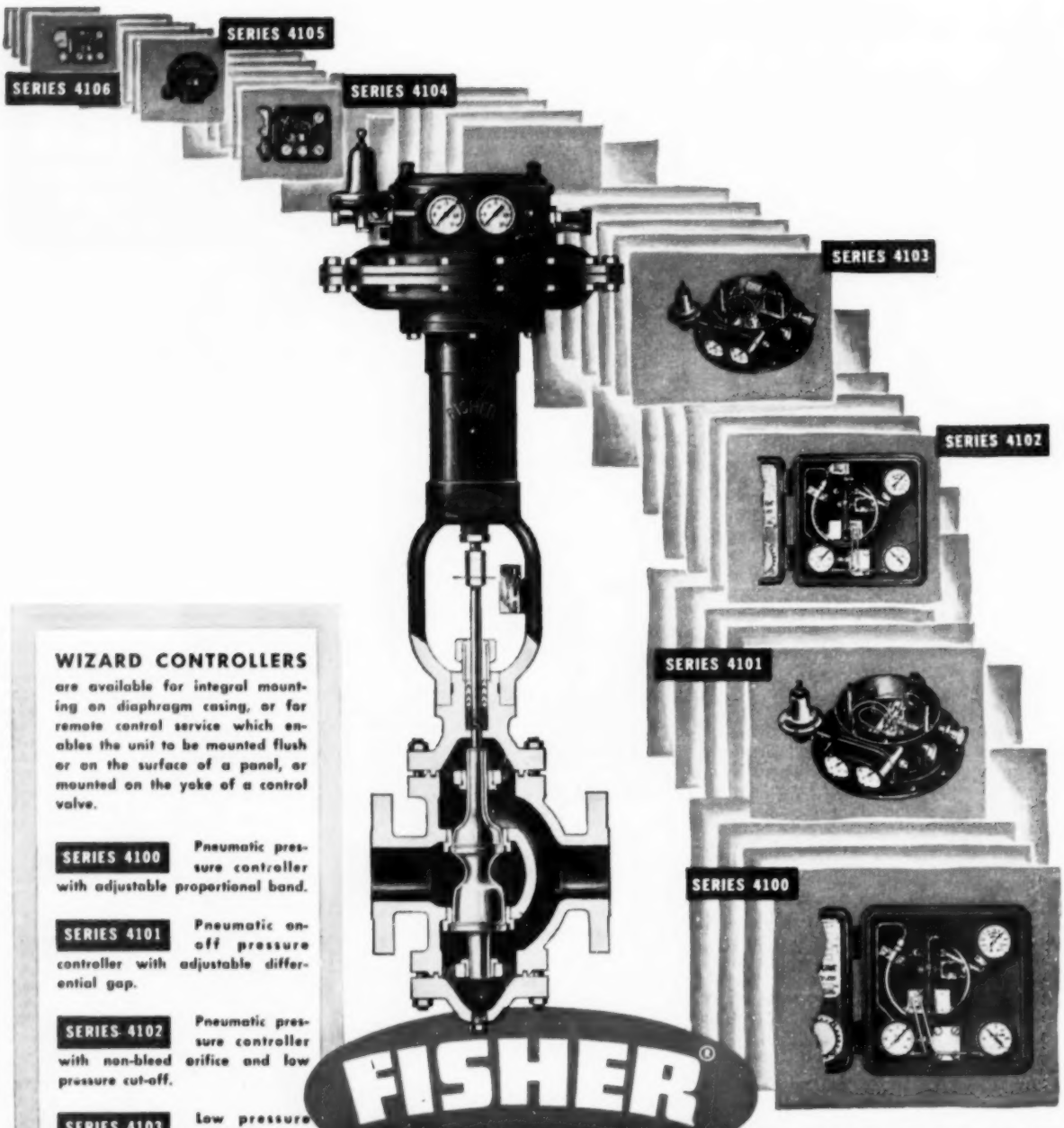
PALMER

THERMOMETERS, INC.

Cincinnati 17, Ohio • MElrose 1500

(To obtain more data on advertised products see page 128)



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SERIES 4100 Pneumatic pressure controller with adjustable proportional band.

SERIES 4101 Pneumatic on-off pressure controller with adjustable differential gap.

SERIES 4102 Pneumatic pressure controller with non-bleed orifice and low pressure cut-off.

SERIES 4103 Low pressure Wizard, bellows actuated with differential gap.

SERIES 4104 Wizard controller with differential gap and non-bleed pilot.

SERIES 4105 Bellows actuated differential pressure controller.

SERIES 4106 Low pressure, bellows actuated, Wizard pressure controller.

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WIZARD PRESSURE CONTROLLERS

Available in a variety of constructions for your particular requirements in the CHEMICAL PROCESS INDUSTRIES, GAS DISTRIBUTION, PIPE LINE TRANSMISSION, POWER PLANTS, REFINERIES, OIL PRODUCTION and GENERAL INDUSTRIAL APPLICATIONS.

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WORLD LEADER IN THE MANUFACTURE OF LIQUID LEVEL CONTROLLERS, PRESSURE REGULATORS AND IN RESEARCH FOR BETTER CONTROL

(*To obtain more data on advertised products see page* 128)

Ethyl Promotes Three

Malcolm P. Murdock has been elected a vice president and director of the Ethyl Corp. Julian J. Frey has been promoted from sales manager, operations, to assistant vice president, and Harold R. Berg from Southern regional manager to general manager of anti-knock sales.

Mr. Murdock

Mr. Frey

Mr. Berg

Mr. Murdock assumes the responsibilities of sales activities as the successor to Sanford M. Wagner, who will retire as vice president and director in February. Murdock joined the company 20 years ago as a field representative in the New York division. He was made motor clinic manager in 1938 and has served as assistant manager of the Los Angeles and Chicago divisions, sales manager of Ethyl Specialties Corp., and Central region manager.

As assistant vice president, Mr. Frey will assist in the formation and administration of sales policies. He has been with Ethyl 25 years, first in the engineering dept., and later as manager of the technical service division in Detroit. In 1944 he was transferred to New York where he filled several executive posts with the sales dept.

Mr. Berg has been manager of the Southern region in Tulsa for the past six years, having joined Ethyl as a field representative in Chicago in 1928. From 1930 to 1945 he was assistant manager of the Chicago division and manager of the Kansas City division.

Fluor Names Canadian Prexy

J. P. Wiseman, sales director and vice president of Fluor Corp., Los Angeles, has been named president of the newly formed subsidiary, Fluor Corp. of Canada, with offices established at Toronto, Ont., after the first of this year.

John G. Marshall, formerly Fluor's chief engineer, has been appointed vice president in charge of engineering, and D. H. White, of the firm's Chicago office, becomes sales manager of the new Canadian company. Fluor is engaged at present in design and construction work throughout Canada, including Shell at Vancouver and Imperial Oil at Regina.

William Hudson has been named manager of domestic construction, a newly created post, for Fluor Corp., with offices in Los Angeles.

James Tathwell has been appointed chief project engineer for Fluor's general engineering division, succeeding Frank Crawford who became manager of the general engineering division. He replaced John Marshall, newly-designated vice president of Fluor of Canada.

Other Fluor apopintments include: Rabon Smith, as chief project engineer for the Mid-continent division, replacing Mr. Tathwell, and Ben Douglass, as project engineer at Wood River, Ill., replacing Mr. Smith.

Oriolo Joins Cat Construction

Dominic J. Oriolo has been added to the process engineering staff of the Catalytic Construction Co. in Philadelphia. His post will be that of project director on one of Catalytic's major operations.

Mr. Oriolo

He comes to the firm from Rohm and Haas Co., where he spent five years as plant development engineer dealing with design, operation, and technical service or chemical plants. Prior to that he had accumulated eight years of supervisory engineering experience in design, development, and operation of pilot plants for petroleum and petrochemical processes.

Graver's O'Brien Honored

Hubbert L. O'Brien, product manager for conservation equipment, Graver Tank & Mfg. Co., Inc., East Chicago, Ind., was honored for "outstanding achievement within 10 years after graduation" by the American Society of Mechanical Engineers at their annual Achievement Awards Dinner in New York in December. He received the Pi Tau Sigma gold medal award.

A 1946 graduate in mechanical engineering from Purdue, O'Brien continued at that school on a Standard Oil Co. (Indiana) fellowship. He received his M.S. after serving as project engineer for the Pressure Vessel Research Project. With Graver since 1949, he is a registered professional engineer in Indiana and the author of a book "Petroleum Tankage and Transmission," as well as numerous technical articles.

Attapulgus Clay Sold

Announcement has been made of the sale of the fullers earth business of the former Attapulgas Clay Co. to Minerals Separation North American Corp., the combination to operate under the new name of Attapulgus Minerals & Chemicals Corp.

Officers of the new firm include: David E. Lilienthal, formerly chairman of the Atomic Energy Commission, as board chairman, Frank A. Howard, formerly vice president of Standard Oil Co. (New Jersey) and retired vice president of Standard Oil Development Co., has been named to the board of directors.

General offices will be at 210 West Washington Square, Philadelphia. Same management personnel will direct activities as heretofore. The company will also act as executive sales agent for Porocel Corp., producers of activated bauxites, in which corporation it is a half-owner with American Cyanamid Co.

Bruun Heads Hooker Research

J. H. Bruun has joined Hooker Electrochemical Co. as director of research and will have charge of a greatly expanded research activity, including plans for new centralized laboratories.

Dr. Bruun

At one time manager of the research division of Sun Oil Co. — from 1932 to 1942 — Dr. Bruun came to Hooker after ten years with General Aniline and Film Corp. During his work with GAF, he served as assistant to the vice president of operations, director of commercial development, director of research of the central research laboratories, acting works manager at the Rensselaer plant, and director of the process development dept.

Before joining Sun, Dr. Bruun had been with the National Bureau of Standards and American Aniline Products. In 1930, he was elected to the Washington Academy of Science

in recognition of his contributions to the chemistry of petroleum. A graduate of Norwegian Institute of Technology, he holds a PhD in physical and organic chemistry from the Johns Hopkins University.

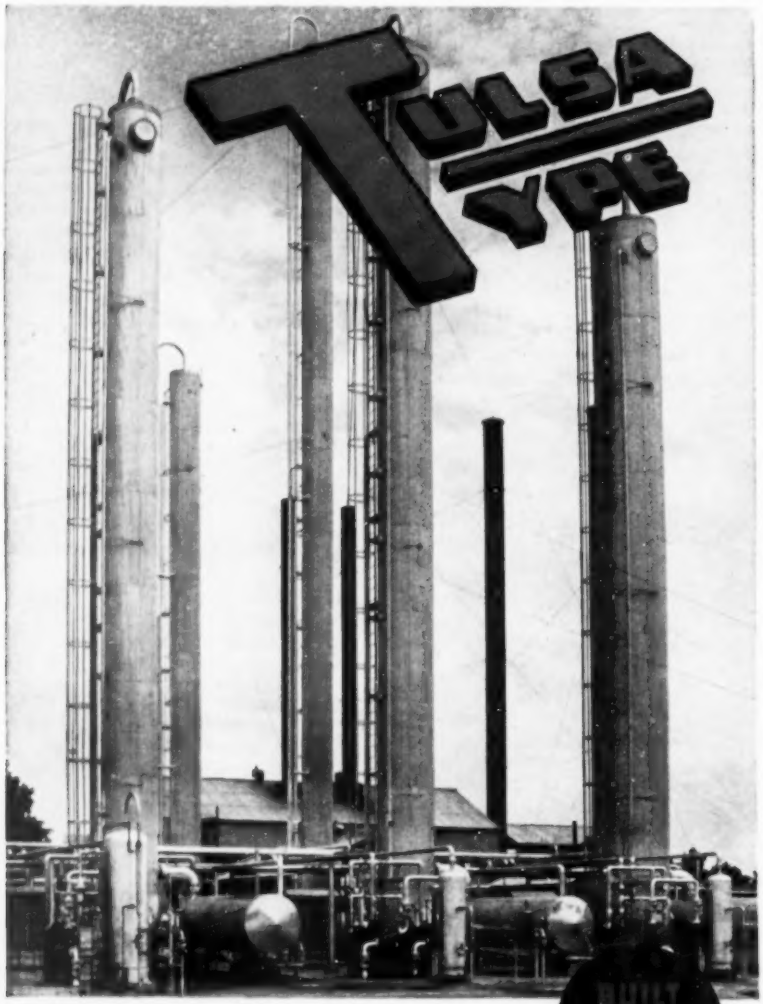
Barnes Opens Toronto Office

W. M. Barnes Co., Los Angeles, has opened the office of W. M. Barnes Co. of Canada, Ltd. at 146 Wellington St., West Toronto, Ont., to handle the company's increased activities in the petroleum and chemical industries of Canada. The new set-up is designed to offer service in process and mechanical engineering; puchasing, expediting, and materials inspection; and construction work. Fred J. Underwood is general manager of the Canadian operations and H. B. Williams is manager of engineering.

Vulcan Adds to Staff

Vulcan Engineering Division, Vulcan Copper & Supply Co., Cincinnati, has named two additions to the engineering staff. Harry W. Haines, Jr., a development engineer, was formerly a Fellow of the Mellon Institute of Industrial Research, holding a multiple fellowship sustained by the Texas Gulf Sulphur Co. A graduate of the University of Illinois, he has an M.S. in Chemical Engrg. from the University of Pittsburgh.

Martin Fields is assistant project engineer. Before joining Vulcan, he was associated with Takamine Laboratories and First Machinery Corp. A graduate of CCNY, he obtained an MS. in Chemical Engineering at New York University.



TULSA TYPE Deethanizer, Depropanizer and Debutanizer Columns in natural gasoline plant.

FLINT STEEL CORPORATION
TULSA, OKLAHOMA

Bechtel Promotes Two

T. W. Brady has been named manager of construction of Bechtel Corp.'s refinery division, with headquarters in San Francisco. He succeeds James Brady, who has been assigned to direct engineering and construction phases of an Aden project in the Middle East. Earl Lindauer has been assinged to superintend construction of a refinery at Bahrein by Mediterranean Builders Co., Inc., a Bechtel Corp. subsidiary.

A graduate of the University of Oregon in 1932, Mr. Moran joined Bechtel in 1940. For the past 10 years he has been superintendent or assistant superintendent on refinery projects, most of them additions to Standard Oil Co. of California's Richmond refinery.

An 11-year Bechtel veteran, Mr. Lindauer has served two previous tours of duty in the Middle East—at Bahrein as pipe foreman for C. C. Bechtel-McCone, 1943-45, and on Tapline as a superintendent, 1949 to May, 1952.

Personnel Changes

Colonial Iron Works Co.—W. J. Hegerty to sales manager of the chemical and process equipment division: from manager of the firm's New York district office.

The Duriron Co.—Richard Schermer to manager of pump sales; from building equipment sales manager. Wendell A. Watkins to Chicago district manager from similar post at Buffalo. D. E. Christie to manager of the Buffalo territory.

Brea Chemicals, Inc.—R. H. McGough to manager of sulfur products sales, with offices in the Petroleum Bldg., 714 West Olympic Blvd., Los Angeles: from by-products chemical division of Union Oil Co. of California.

Fritz W. Glitsch & Sons, Inc.—W. R. Greenman to manager of the Chicago office; from the Dallas territory. Greenman will be responsible for Illinois, Indiana, Wisconsin, Mich-

(To obtain more data on advertised products see page 128)

igan (except the Detroit area), Missouri except extreme western section), and the western part of Kentucky.

Airetool Mfg. Co.—Artis M. Duty to sales engineer in the Houston branch office.

Alloy Casting Institute—Ernest A. Schoefer, to newly-created office of executive vice president, from executive secretary. Mr. Schoefer has been with the Institute since 1940, when it was formed, and before that with the Alloy Casting Research Institute, its predecessor.

Branches, Distributors

Insul-Mastic Corp. of America has signed contracts with three coating applicators for representation in the Southwest. They are Industrial Insulators, Inc., Borger, Texas; Ozark Insulation Co., Inc., Little Rock, Ark.; and Rust-Proofing, Inc., Phoenix, Ariz.

Hammel - Dahl Co., Providence, R. I., has appointed the Control Equipment Co., 1222 Peachtree Street, N.E., Atlanta 3, Ga., as additional sales and service representatives in the south.

Milton Roy Co., Philadelphia, has announced the appointment of the Tower Equipment Co. as representatives in the entire State of Washington except for the southeastern counties.

Expansion, Transition

Wakefield Industries, Inc., of Skokie, Ill., manufacturers of scientific glassware, have announced acquisition of Del-Mar Scientific Glass Co., 2018 North Keystone Ave., Chicago. All personnel were transferred to a new plant in Skokie last month.

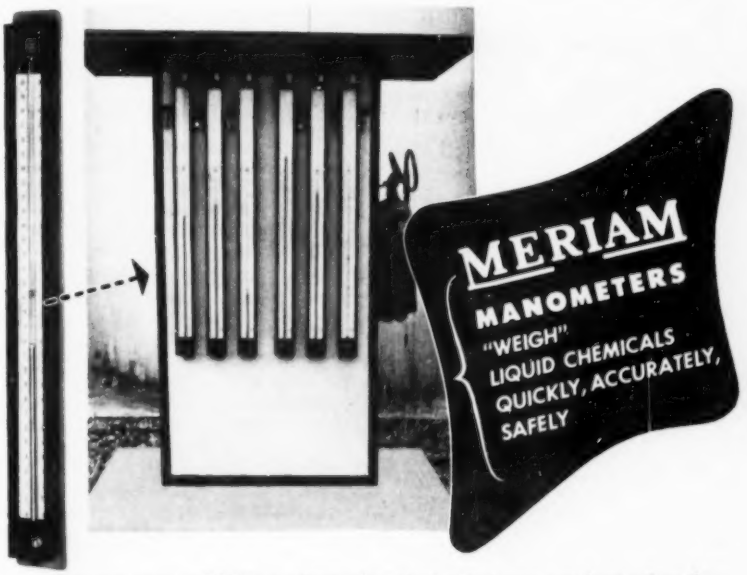
Permutit Co., which has just completed its 1952 program of doubling capacity of the Birmingham, N. J. works for the production of ion exchange resins, has now placed contracts for further expansion, including a new laboratory and pilot plant building at an estimated cost of $200,000.

The United States Steel Co., a subsidiary of United States Steel Corp., has been merged into the parent corporation, as of December 31, 1952.

Mathematical Computing Service, 105 Court St., Brooklyn 2, N. Y., is a new firm established to perform service for industry needing engineering calculations, charts and nomographs of a high degree of complexity and offering service in handling mathematical problems in the field of petroleum engineering.

The Jones & Laughlin Supply Co., Tulsa, a wholly-owned subsidiary of Jones & Laughlin Steel Corp., has become a division of J&L. Canadian assets of the J&L Supply Co. will be sold to the J&L Steel Sales Co. Ltd., a Canadian subsidiary, which will carry on the Canadian business previously conducted by the Supply company. The newly-named supply division will be headed by Rainey Elliott of Tulsa, who has been vice president and director of the supply firm. John L. Shakely, president of the Supply company, is retiring from active service after 39 years with the firm and its predecessor, Frick-Reid, but will remain with the new division in a consulting capacity.

Calumet and Hecla Consolidated Copper Co. has announced a change in company name to Calumet & Hecla, Inc.



A prominent middle western chemical plant was confronted with the need to proportion, by weight, hazardous chemicals in formulating products. Personnel safety and need for immediate, exact knowledge for correct formulation, added to the problem.

Meriam Manometers provided the answer. In formulating liquid chemical products, direct weight readings are taken as various chemicals are added to the tanks. No tedious, involved mathematical calculations. No danger of injury to personnel through burning or falling. *Manometers give required information at a glance—saving time and expense.*

If you are confronted with difficult process indication requirements—involving measurement of flow or pressures of liquids and gases, consult the Meriam Representative in your vicinity or write us.

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In Canada: Peacock Bros., Ltd., Montreal

MERIAM Instruments

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MANOMETERS, METERS AND GAUGES FOR THE ACCURATE MEASUREMENT OF PRESSURES, VACUUMS AND FLOWS OF LIQUIDS AND GASES

(To obtain more data on advertised products see page 128)

Nitrogen Thermodynamic Properties Charts Fill Plant Design Needs

Thermodynamic Properties of Nitrogen, by O. T. Bloomer and K. N. Rao. Institute of Gas Technology Research Bulletin 18; 8½ x 11 in., 32 pages, illustrated, soft paper bound booklet. $3.50.

Mollier Chart for Nitrogen and *Compressibility Chart for Nitrogen*. Supplement No. 18 taken from Bulletin 18 and reproduced full scale (grid 10 x 10 to the inch). Each chart printed on heavy paper, 22 x 24 in., sold as set only (two sheets), $3.50 per set. The Institute of Gas Technology, Technology Center, Chicago 16, Ill.

Nitrogen is chemically inert, and is a non-combustible diluent lowering the heating value of natural gas in direct proportion to its concentration. The cost of transmission of natural gas per Btu unit is directly influenced by the nitrogen concentration, which as a high molecular weight constituent increases the horsepower required for pumping.

Proposals have been made to remove nitrogen prior to transmission as a means of increasing pipeline effectiveness. Further, the removal of propane and ethane from high-nitrogen natural gas for petrochemical manufacture requires the removal of nitrogen to insure maintenance of heating value requirements on the gas. Also, the storage of liquefied natural gas for meeting peak loads requires separation of the nitrogen to insure uniformity of the natural gas when removed from storage.

The engineering design of plants to separate nitrogen from natural gas requires accurate data on the thermodynamic properties of nitrogen over a wide range of conditions. Previously published charts either cover an inadequate range of pressure or suffer from scale modulus limitations. To provide charts of value to the natural gas industry, researchers at the Institute of Gas Technology, affiliated with Illinois Institute of Technology, have re-calculated the usual thermodynamic properties of nitrogen on the basis of more recent fundamental data from the published literature.

The IGT Research Bulletin 18 presents the properties in tabular form and as charts of enthalpy vs. entropy, and of compressibility factor as a function of temperature and pressure. The range of the tables and charts is from saturated liquid at −320.4° F. to superheated vapor at 500° F., and pressures from 10 to 1500 psia. Properties tabulated are specific volume, enthalpy, entropy, and the fugacity-to-pressure ratio. For the superheated vapor region, calculations were based on zero-pressure specific heat data and a new equation of state.

As a working supplement to Bulletin 18, the Mollier and the compressibility charts have been reproduced full scale on heavy paper, 22 x 24 in. They may be obtained separately from the bulletin.

European Group Studies U.S. Refiners, Drillers

Oil Refining and Drilling in the U.S.A., a Report by a Group of European Experts. Technical Assistance Mission No. 6, published by the Organization for European Economic Co-operation; 6 x 9½ in., 264 pages, indexed, heavy paper cover. Columbia University Press, 2960 Broadway, New York 27, N. Y. $5.00.

Petroleum processors will be thoroughly interested in the first half of this book, dealing with a kind of quick survey of the American refining industry as seen through the eyes of European engineers.

Subject matter is well written and comparatively up-to-date on today's methods. It includes crude oil distillation, polymerization, sulfur recovery, various catalytic cracking and reforming processes, lube oil manufacture, instrumentation, research, maintenance, and general organization. A number of flow sheets illustrate the major processes discussed.

While the work is by no means a technical treatise, it is fairly comprehensive, considering that the team of eight men—representing Austria, the Netherlands, France, Germany, and Italy—spent an actual total time of some six weeks in their tour of this country. It is their hope, as stated in the preface, that the "report will prove useful to executives and technicians (in Europe) and that it will give a general but accurate idea of American technique, as a basis for further improvements in the European oil industry."

The Chemistry of Maleic Anhydride and Derivatives

Maleic Anhydride Derivatives, by Lawrence H. Flett and William Howlett Gardner; 6 x 9 in., x + 269 pages, indexed, stiff cloth binding. $6.50. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y.

This book should prove invaluable to the research chemist. One hundred and sixteen types of chemical reactions involving maleic anhydride or one of its simple unsaturated derivatives are contained in its pages. Most of the reactions illustrate the chemistry of the double bond.

The activity of the unsaturated ethylene bond, enhanced by the two adjacent carbonyl groups, is such that it can be depended upon to undergo almost any reaction that is characteristic of unsaturated organic compounds. Some of the uses found for the products derived from the synthesis of maleic anhydride or one of its derivatives include: oil additives, detergents, adhesives, organic pigments, and rubber.

Hydrocarbons, halogens and their compounds, hydrogen, metallic compounds, compounds containing nitrogen, oxygen, sulfur compounds, and energy and catalysts make up the chapter headings. Reactions involving carbon and hydrogen are found in the first chapter, thereafter the following chapters contain reactions of the other elements, in alphabetical sequence.

An interesting feature of the book is its deliberate format. Each preparation is conveniently arranged across two facing pages. The right-hand page includes the net equation and a description of the method. Comments, a description of the reaction products, and possible uses are given on the left-hand page.

The authors are Lawrence H. Flett and William Howlett Gardner. Both are associated with the New Products Division, National Aniline Division, of the Allied Chemical and Dye Corp.

D-2 Revises '48 Manual On Engine Test Methods

ASTM Manual of Engine Test Methods for Rating Fuels—1952; 6 x 9 in., xvi + 342 pages, indexed, stiff green cloth binding. American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa. $8.00.

This new edition of the Manual incorporates all of the changes in the five standard methods for rating motor, aviation, and Diesel engine fuels that have been adopted since their earlier publication in 1948. Six extensively revised supplements contain information on the best practices currently in use for laboratory facilities, installation of the engine test units, provisions for reference materials, and electrical, water and air services, and the operation and maintenance of the units.

Government Publications

Natural Gas Statistics, 1936-50; Bureau of Mines Information Circular 7644, Sept., 1952, by D. S. Colby and B. E. Oppegard; 8 x 10½ in., 35 pages, heavy paper cover.

Removal of Hydrogen Sulfide and Carbon Dioxide from Synthesis Gas using Di- and Tri-ethanolamine, Bureau of Mines Report of Investigations 4891, Oct., 1952, by H. W. Wainwright, G. C. Egleson, C. M. Brock, J. Fisher, and A. E. Sands; 8 x 10½ in., 21 pages, heavy paper cover.

A Selected Bibliography of Coal Gasification, Bureau of Mines Report of Investigations 4926, Nov., 1952, by Robert M. Busche, Howard R. Batcheider, and Willard P. Armstrong; 8 x 10½ in., 28 pages.

Copies of the above publications may be obtained free from the Publications Distribution Section, Bureau of Mines, 4800 Forbes St., Pittsburgh 13, Penna.

'Oil Refining in Mexico' Is Subject Of Dinner Talk at WPRA Meeting

DAVE THORNTON, Southwestern Editor of PETROLEUM PROCESSING, is the featured dinner speaker at the regional meeting of the Western Petroleum Refiners Assn., in Beaumont, Texas, next month, Feb. 12-13. His subject will be "Oil Refining in Mexico," based on a 2-month study he recently made of the industry there. The dinner is scheduled for Thurs., Feb. 12.

First day of the 2-day meeting will be devoted to industrial relations, and will be presided over by L. B. Gough, manager of industrial relations for Magnolia Petroleum Co., in Beaumont.

The second day will be concerned with a technical session, with V. A. Kalichevsky, consulting chemical engineer with Magnolia, presiding.

Both sessions will be held in the Hotel Beaumont. The complete program follows:

Thursday, Feb. 12
Industrial Relations Session

"How to Train"—A film concerning the four steps of proper job instruction. Mr. W. W. McMullen, Jr., Training Director, Magnolia Petroleum Company, Beaumont, Texas will discuss the various phases shown.

"The Techniques of Training Foremen"—Robert L. Nichols, Division Foreman, Magnolia Petroleum Company, Beaumont, Texas.

"Participation—Key to Supervisor Cooperation"—F. E. Mathews, Superintendent, Industrial Relations Division, Standard Oil Company (Ind.) Casper, Wyoming.

"Preparation for Retirement"—W. P. Reymond, Jr., Employee Relations Manager, Esso Standard Oil Company, Baton Rouge, Louisiana. A film depicting the activities of retired Esso employees will be shown in connection with Mr. Reymond's discussion.

Industrial Relations Panel Discussion
Panel Members: R. B. McHenry, Employee Relations Director, Gulf Oil Corporation, Port Arthur, Texas. K. R. Dailey, Assistant Manager, Employee Relations Department, Humble Oil & Refining Company, Houston, Texas. H. C. Reiniger, Director of Industrial Relations, Pan-American Refining Company, Texas City, Texas. Joe Boston, Director of Industrial Relations, Atlantic Refining Company, Port Arthur, Texas.

Cocktail Hour—Courtesy the Refinery Supply and Service Group.

Informal Dinner—The speaker will be D. P. Thornton, Jr., Southwestern Editor, PETROLEUM PROCESSING, Houston, Texas. His topic: *"Oil Refining in Mexico"*.

Friday, Feb. 13
Technical Session

"Arosorb Process"—Frank R. Shuman, Sun Oil Company, Marcus Hook, Pennsylvania.

"Some Aspects of Lubricating Oil Manufacture"—Dr. E. P. King, The Pure Oil Company, Nederland, Texas.

"Limitations of Statistical Quality Control Methods"—L. J. McGovern, Magnolia Petroleum Company, Beaumont, Texas.

"Pollution Creates an Attitude"—K. E. Mills, Pan-American Refining Corporation, Texas City, Texas.

"Corrosion in Action"—A color film dealing with the various types of corrosion problems and remedial procedures. Film shown through the courtesy of The International Nickel Company, New York City.

API Arranges Annual Meetings Through 1955

American Petroleum Institute's 1953 and 1954 annual meetings will be held in Chicago, and the 1955 annual meeting is scheduled for San Francisco. Specific dates are: November 9-12, 1953; November 8-11, 1954; and November 14-17, 1955.

API Accepting Ideas For Mid-Year Papers

THE Division of Refining, American Petroleum Institute, is now accepting ideas for papers which are to constitute a major portion of the program at the mid-year meeting at the Commodore Hotel in New York next May 11-14. Topics should be submitted promptly with a brief description of the contents of the proposed paper. If accepted, manuscripts are to be submitted by February 1 to allow time for editing and pre-printing.

Anyone desiring to offer papers should communicate with W. T. Gunn, director, of the API, Division of Refining, American Petroleum Institute, 50 West 50th St., New York 20, N. Y. or the delegated committee chairmen:

Analytical Research: E. L. Baldeschwieler, Standard Oil Development Co. P. O. Box 51, Linden, N. J.:

Deterioration of Metals: N. J. Rees, Socony-Vacuum Oil Co. Inc., 26 Broadway, New York, N. Y.:

Electrical Equipment: L. M. Goldsmith, The Atlantic Refining Co., 260 South Broad St., Philadelphia, Pa.:

Corrosion of Refinery Equipment: E. Q. Camp, Humble Oil & Refining Co., P. O. Box 3538, Houston, Texas:

Refinery Waste Disposal: R. N. Giles, Standard Oil Co. (Ind.), 910 South Michigan, Chicago, Ill.:

Motor Fuels: J. Bennett Hill, Sun Oil Co., Marcus Hook, Pa.:

Personnel Training: A. E. Houseknecht, Esso Standard Oil Co., 15 West 51st St., New York, N. Y.:

Lubricating Oils: J. C. Geniesse, The Atlantic Refining Co., 3144 Passyunk Ave., Philadelphia, Pa.:

Processes: F. W. Schumacher, Standard Oil Development Co., P. O. Box 121, Linden, N. J.

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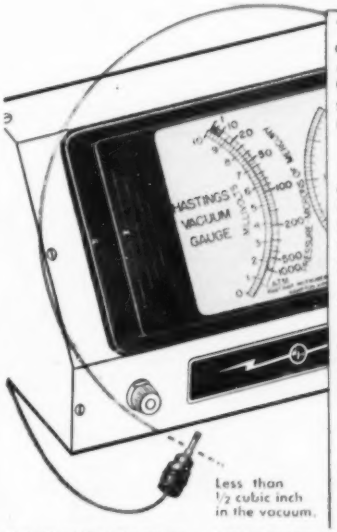

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(To obtain more data on advertised products see page 128)

Petrochem Lecture Series Starts Feb. 3 in N.J.

A SERIES of 10 lectures on "Petrochemicals" is being sponsored by the North Jersey Section of the American Chemical Society, starting Feb. 3. The lectures will be held at Roosevelt School Auditorium in Rahway, N. J. every Tuesday evening from 7 to 9 p.m., through April 7.

Anyone interested is eligible to attend, with fees for the complete series as follows: members of ACS—$8.50; non-members—$15.00; students—$5.00. No reduced rates are being offered for single lectures or any part of the series.

Enrollment forms can be obtained from Robert E. Jones, in the Research and Development Dept., Merck and Co., Inc., Rahway.

The lectures so far scheduled and the lecturers are as follows:

"The Scope and Growth of the Petrochemical Industry", Dr. R. L. Bateman, Carbide & Carbon Chemical Co., Feb. 3.

"Aliphatic Chemicals—Olefin Derivatives", Dr. J. P. Cunningham, Shell Chemical Corp., Feb. 10.

"Aliphatic Chemicals—Olefin Oxides", Mr. J. A. Field, Carbide & Carbon Chemical Co., Feb. 17.

"Aliphatic Chemicals — Carbon Monoxide Derivatives", Dr. Milton Orchin, U. S. Bureau of Mines, Feb. 24.

"Aliphatic Chemicals—Natural Gas Oxidation", Dr. O. V. Luke, Celanese Corp. of America, March 3.

"Aromatic Chemicals from Petroleum", Mr. D. S. Maisel, Standard Oil Development Co., March 10.

"Detergents from Petroleum", Mr. L. H. Flett, Allied Chemical & Dye Corp. and Dr. R. L. Wakeman, Quaker Chemical Products Corp., March 17.

"Hydrocarbon Monomers for Production of Polymers", Mr. S. E. Jaros, Standard Oil Development Co., March 24.

"Non-hydrocarbon Monomers for Production of Polymers", Dr. C. E. Schildknecht, Consulting Chemist, Montclair, N. J., March 31.

"Nitrogen and Sulfur Derivatives from Petroleum", Dr. J. E. Mahan, Phillips Petroleum Co., April 7.

WANTED—TECHNICAL WRITER

We need a technically-trained man, under 30, for the editorial staff of PETROLEUM PROCESSING. He should have a background of mechanical engineering and experience in refining or petrochemical manufacturing operations—with emphasis on equipment. He should be able to write clearly and cleanly, and have done some work in preparing reports.

He should have an inquisitive mind and like to probe into the "why" of things, and be able to explain to others what he has found out.

Experience in magazine or newspaper production is desirable but not essential.

Duties will include editing and rewriting copy, with responsibility for specific departments in the magazine, and field trips to gather data for original articles. Location is in Cleveland, and salary is open. Send details to:

EDITOR, PETROLEUM PROCESSING

1213 West Third Street • Cleveland 13, Ohio

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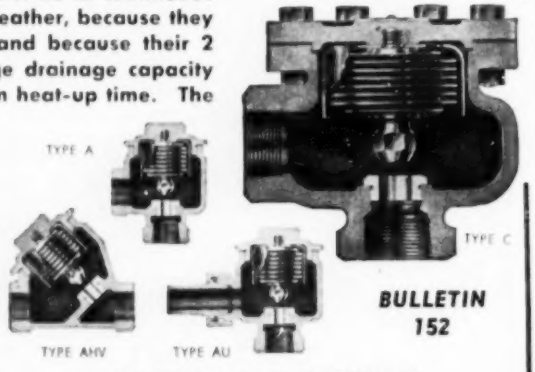
Because they drain completely when cold, these four types of Nicholson steam traps are positively freeze-proof. Can be freely installed outdoors. Universally recommended for use in lines which need not be in continuous use during cold weather, because they are freeze-proof and because their 2 to 6 times average drainage capacity results in minimum heat-up time. The non-air-binding feature of Nicholson traps also notably facilitates heat transfer in severe weather. Sizes ¼" to 2"; pressures to 250 lbs.



BULLETIN 152

215 OREGON ST., WILKES-BARRE, PA.

W. H. NICHOLSON & CO.

TRAPS · VALVES · FLOATS

Oil Man's Calendar

1953

JANUARY

American Society for Testing Materials, Committee D-19 on Industrial Water, St. Louis, Mo., Jan. 26-28.

A. and M. College of Texas, Symposium on Instrumentation for the Process Industries, Memorial Student Center, College Station, Texas, Jan. 28-30.

FEBRUARY

National Assn. of Corrosion Engineers, Five-day short course in corrosion in cooperation with University of California's extension department and departments of mechanical engineering, mineral technology and chemical engineering, Berkeley, Calif., Feb. 2-6.

Western Computer Conference, Sponsored jointly by Computer Conference Committee of the Institute of Radio Engineers and the American Institute of Electrical Engineers, Hotel Statler, Los Angeles, Calif., Feb. 4-6.

Western Petroleum Refiner's Assn., regional meeting, Hotel Beaumont, Beaumont, Texas, Feb. 12-13.

Instrument Society of America, New York Section, sixth annual regional meeting, Hotel Statler, New York, N. Y., Feb. 18.

Natural Gasoline Assn. of America, regional meeting, Scharbauer Hotel, Midland, Texas, Feb. 27.

MARCH

American Society for Testing Materials, Spring meeting and Committee Week, Hotel Statler, Detroit, Mich., Mar. 2-6.

American Society for Testing Materials, Committee E-14 on Mass Spectrometry, Pittsburgh Conference, Pittsburgh, Pa., Mar. 3-7.

American Institute of Chemical Engineers, Buena Vista Hotel, Biloxi, Miss., Mar. 8-11.

National Assn. of Corrosion Engineers, Ninth Annual Conference & Exhibition, Hotel Sherman, Chicago, Ill., Mar. 16-20.

Western Petroleum Refiners Assn., annual meeting, Plaza Hotel, San Antonio, Texas, Mar. 23-25.

American Society for Metals, Eighth Western Metal Congress and Exposition, Pan-Pacific Auditorium, Los Angeles, Calif., Mar. 23-27.

APRIL

Assn. of Consulting Chemists & Chemical Engineers, symposium, Hotel Belmont-Plaza, New York, N. Y., Apr. 21.

American Inst. of Chemical Engineers and **Chemical Institute of Canada,** joint meeting, Royal York Hotel, Toronto, Canada, Apr. 26-29.

Natural Gasoline Assn. of America, 32nd annual convention, Rice Hotel, Houston, Texas, Apr. 29-May 1.

MAY

American Petroleum Institute, Division of Refining, mid-year meeting, Hotel Commodore, New York, N. Y., May 11-14.

International Petroleum Exposition and Congress, Hall of Science, Tulsa, Okla., May 14-23.

Materials Handling Exposition, Convention Hall, Philadelphia, Pa., May 18-22.

Scientific Apparatus Makers Assn., annual meeting, The Greenbrier, White Sulfur Springs, W. Va., May 24-28.

Western Petroleum Refiners Assn., regional technical-industrial relations meeting, Hotel Broadview, Wichita, Kans., May 28-29.

10% Larger Heating Oil Stocks Jan. 1 Ample Cushion for Severe Late Winter

PRIMARY heating oil stocks (kerosine and distillate fuels) to start 1953 were at a level where shortages in supplies in local distributors' hands in the late winter do not seem likely, even if temperatures are considerably below normal.

Heating oil stocks Nov. 1, 1952, at the start of the withdrawal period, were larger than the year before. The rate of withdrawals so far this season has not been as large as last season. Total U. S. stocks Dec. 27, 1952, were 12% larger than on Dec. 29, 1951. East of California stocks were 10% greater.

Crude runs to stills are holding close to 7,000,000 b/d avg. Runs of 6,940,000 b/d are forecast by the Bureau of Mines for January and of 6,920,000 b/d for the first quarter of '53. These high crude runs, together with a yield of distillate fuels of around 22%, provide for a refinery output of heating oils of about 1,900,000 b/d avg. Heating oil demand for the first quarter is forecast at about 2,260,000 b/d avg. The current difference between refinery production and forecast demand does not indicate unduly high withdrawals in coming weeks.

In the East Coast refining district, where shortages of heating oils to consumers have been predicted about every year, refiners' stocks of kerosine and distillate fuels combined on Dec. 27, 1952, were 17% larger than on Dec. 29, 1951. Conditions in this area are more favorable this winter for tanker shipment of supplies from the Gulf Coast, because of a drop of nearly one third in tanker rates and because of a price adjustment given earlier this year to heating oil jobbers in the area.

When seasonal withdrawals of heating oil stocks started in November, East Coast inventories were about 4,000,000 bbls. higher than at the start of the 1951 heating season. Drafts on stocks to Dec. 27 have been about 8,400,000 bbls., while for the same number of weeks in 1951 they were around 12,000,000 bbls. These two factors account for East Coast stocks Dec. 27 being over 7,000,000 bbls. higher than on the same relative date in 1951. (See Table 1).

In the Gulf Coast district, heating oil stocks early November last, were about 1,400,000 bbls. less than the year before. Withdrawals this season have been a little larger. Stocks here on Dec. 27 were 1,700,000 bbls. lower than Dec. 27, as compared with Dec. 29, 1951.

Heating oil stocks in the Ind.-Ill.-Ky. district were about the same at the start of the 1952-53 and the 1951-52 heating seasons. Drafts here to the first of the year were about 2,500,000 bbls. less than the year before, which accounts for the larger volume in refiners' tanks to start 1953.

In the Okla.-Kans.-Mo. district, stocks to start the current heating season were about 1,600,000 bbls. higher than the year preceding. Withdrawals have been about 300,000 bbls. less than this year, which accounts for the 1,900,000 bbls. more in inventories at the end of December, 1952. East of California stocks of heating oils were 4,500,000 bbls. higher at the start of the current heating season and drafts have been about 6,300,000 bbls. less, which accounts for the larger inventories this December last by 10,800,000 bbls.

U. S. gasoline stocks Dec. 27, '52, of 134,425,000 bbls. were only about 1,350,000 bbls. larger than refiners' stocks on Dec. 29, 1951. The buildup in these stocks from early November was close to 14,000,000 bbls., very little larger than for the same period in 1951. The production of motor fuel in current weeks is running larger than a year ago but demand at refineries the early part of the winter was at a higher rate of increase over 1951 than in the early months of the year. The Mines Bureau's forecast of domestic demand for gasoline for the first quarter of '53 is 4% larger than in '52.

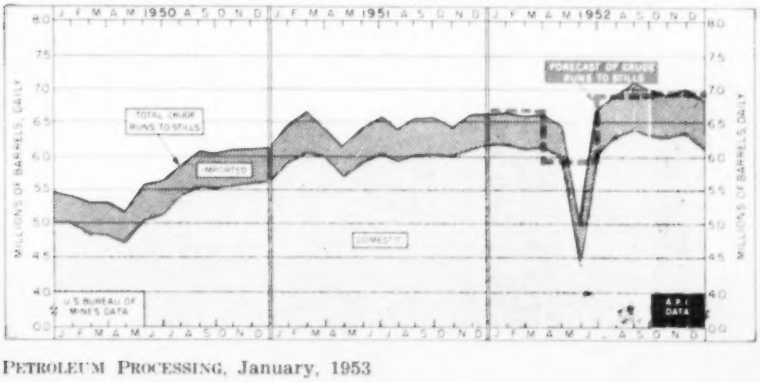
Refiners stocks of gasoline on the East Coast Dec. 27, 1952, were about 1,600,000 bbls. higher than at the end of 1951. Stocks in the Ind.-Ill.-Ky. district were around 1,200,000 bbls. lower. Stocks in the Okla.-Kans.-Mo. area were about 800,000 bbls. higher.

U. S. stocks of residual fuels at the end of 1952 were nearly 8,000,000 bbls. higher than the year before. The gain in inventories has been nearly all in California. For the rest of the country stocks of this product in refiners' hands were about 1,000,000 bbls. higher.

Table 1—Refiners' Stocks of Heating Oils (Kerosine and Distillate) Dec. 27, 1952, and Dec. 29, 1951. (1000 Bbls. API data)

District	Dec. 27 1952	Dec. 29 1951	Change	% Change
East Coast	50,205	42,832	+ 7,373	+ 17
Gulf Coast	21,968	23,671	— 1,703	— 7
Total Coastal	72,173	66,503	+ 5,670	+ 8
Appalachian	3,069	2,538	+ 531	+ 21
Ind.-Ill.-Ky.	24,936	22,423	+ 2,513	+ 11
Okla.-Kans.-Mo.	13,738	11,831	+ 1,907	+ 16
Other Inland	6,124	5,909	+ 215	+ 31
Total East of Cal.	120,040	109,204	+ 10,836	+ 10
California	11,603	8,219	+ 3,384	+ 41
Total U. S.	131,643	117,423	+ 14,220	+ 12

Fig. 1—Crude Runs Hold at Current High Level


J F M A M 1950 A S O N D
J F M A M 1951 A S O N D
J F M A M 1952 A S O N D
MILLIONS OF BARRELS DAILY
TOTAL CRUDE RUNS TO STILLS
IMPORTED
DOMESTIC
FORECAST OF CRUDE RUNS TO STILLS
U.S. BUREAU OF MINES DATA
A.P.I. DATA

Crude Runs to Stills

Daily Average (1000 bbls.)

	Domestic	Foreign	TOTAL
Dec. '52 API*	6,298	587	6,885
Dec. '51 BM	6,214	432	6,646
Change	+ 84	+ 155	+ 239
% Change	1.4	35.7	3.6

*Through Dec. 27

Total (1000 bbls.)
(Bureau of Mines Data)

11 Mos. '52*	2,037,517	187,708	2,225,225
11 Mos. '51	1,996,056	168,316	2,164,372
Change	+ 41,461	+ 19,392	+ 60,853
% Change	2.1	11.5	2.8

*Nov. estimated from API data

BM Forecast of Crude Runs to Stills, 1952

(July 28, 1952; 1000 b/d avg. by quarters)

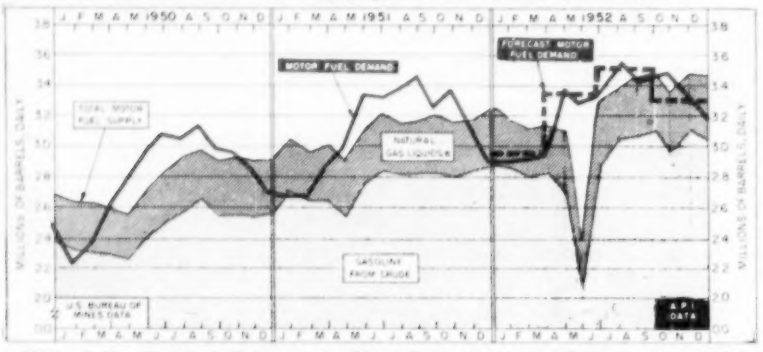
Estimated		Forecast	
1st Q., 6,650	2nd Q., 5,918	3d Q., 6,900	4th Q., 6,950

Yields on Crude Runs to Stills

	Gasoline %	Kerosine %	Dist. Fuels %	Resid. Fuels %
Dec. '52 API*	44.3	6.1	21.9	18.5
Nov. '52 API	44.1	5.6	21.8	17.8
Oct. '52 BM	43.9	5.1	21.2	17.5
Dec. '51 BM	42.9	5.8	21.4	19.4

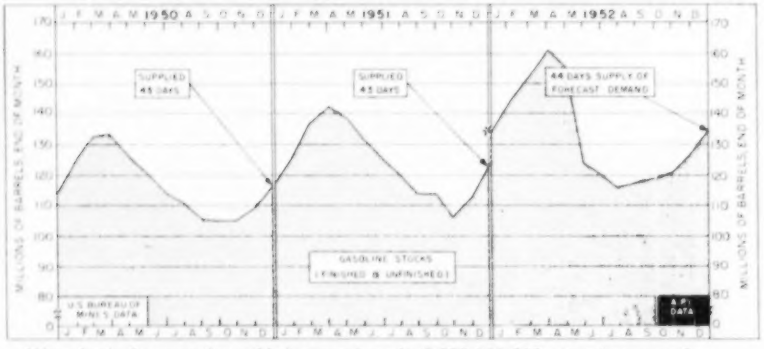
*Through Dec. 27

Fig. 2—"Gas" Supply Over 3,400,000 b/d


J F M A M 1950 A S O N D
J F M A M 1951 A S O N D
J F M A M 1952 A S O N D
MOTOR FUEL DEMAND
FORECAST MOTOR FUEL DEMAND
TOTAL MOTOR FUEL SUPPLY
NATURAL GAS LIQUIDS
GASOLINE FROM CRUDE
U.S. BUREAU OF MINES DATA
A.P.I. DATA
MILLIONS OF BARRELS, DAILY

*Natural Gas Liquids include gasoline blended at refineries, and that used as finished motor fuel.

Fig. 3—Gasoline Stocks Nearly 135,000,000 Bbls.


J F M A M 1950 A S O N D
J F M A M 1951 A S O N D
J F M A M 1952 A S O N D
SUPPLIED 45 DAYS
SUPPLIED 45 DAYS
44 DAYS SUPPLY OF FORECAST DEMAND
GASOLINE STOCKS (FINISHED & UNFINISHED)
U.S. BUREAU OF MINES DATA
A.P.I. DATA
MILLIONS OF BARRELS, END OF MONTH

*New basis for reporting added approximately 9,000,000 bbls. to primary stocks.

Fig. 4—Heating Oil Production is '52 High

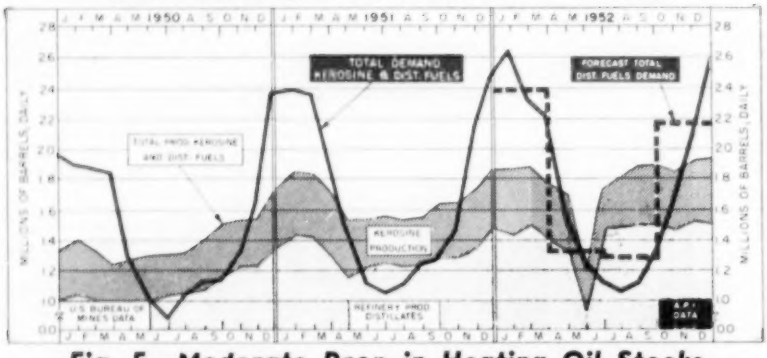
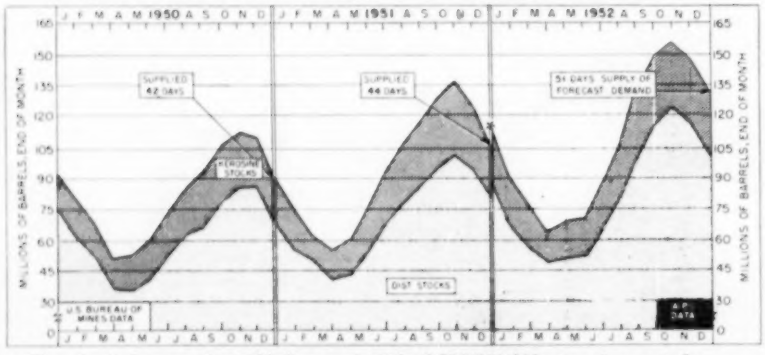

J F M A M 1950 A S O N D
J F M A M 1951 A S O N D
J F M A M 1952 A S O N D
TOTAL DEMAND KEROSINE & DIST. FUELS
FORECAST TOTAL DIST. FUELS DEMAND
TOTAL PROD. KEROSINE AND DIST. FUELS
KEROSINE PRODUCTION
REFINERY PROD. DISTILLATES
U.S. BUREAU OF MINES DATA
A.P.I. DATA
MILLIONS OF BARRELS, DAILY

Fig. 5—Moderate Drop in Heating Oil Stocks


J F M A M 1950 A S O N D
J F M A M 1951 A S O N D
J F M A M 1952 A S O N D
SUPPLIED 42 DAYS
SUPPLIED 44 DAYS
51 DAYS SUPPLY OF FORECAST DEMAND
KEROSINE STOCKS
DIST. STOCKS
U.S. BUREAU OF MINES DATA
A.P.I. DATA
MILLIONS OF BARRELS, END OF MONTH

*New basis for reporting added approximately 4,500,000 bbls. to primary stocks.

Motor Fuel Supply

Daily Average (1000 bbls.)

	Gasoline from Crude	Natural Blended Used Direct	TOTAL
Dec. '52 API*	3,653	410	3,463
Dec. '51 BM	2,864	363	3,227
Change	+189	+47	+236
% Change	6.6	12.9	7.3

*Through December 27

Total (1000 bbls.)
(Bureau of Mines Data)

Nov. '52*	957,265	126,010	1,083,275
Nov. '51	920,850	118,642	1,039,472
Change	+36,415	+7,368	+43,803
% Change	4.0	6.2	4.2

*November estimated from API data

Motor Fuel Demand

Including Exports
Daily Average (1000 bbls.)

Dec. '52 API*	3,196
Dec. '51 BM	2,844
Change	+352
% Change	12.4

*Through Dec. 27

Total (1000 bbls.)
(Bureau of Mines Data)

11 Mos. '52	1,092,924
11 Mos. '51	1,042,408
Change	+50,516
% Change	4.8

*November Estimated from API data

BM Forecast of Motor Fuel Demand, 1952
(July 28, 1952; 1000 b/d ave. by quarters)

Estimated		Forecast	
1st Q., 2,993	2nd Q., 3,360	3d Q., 3,509	4th Q., 3,261

Gasoline Stocks

Finished and unfinished, end of month (1000 bbls.)

Dec. '52 API*	134,425
Nov. '52 API	127,216
Oct. '52 BM	129,062
Dec. '51 BM	134,867

*December 27

Heating Oils Production

(Kerosine and Distillates)
Daily Average (1000 bbls.)

	Kerosine	Dist. Fuels	TOTAL
Dec. '52 API*	423	1,514	1,937
Dec. '51 BM	393	1,442	1,835
Change	+30	+72	+102
% Change	7.7	5.0	5.6

*Through December 27

Total (1000 bbls.)
(Bureau of Mines Data)

11 Mos. '52*	119,207	475,116	594,323
11 Mos. '51	123,571	431,108	554,679
Change	−4,364	+44,008	+39,644
% Change	3.5	10.2	7.2

*November estimated from API data

Heating Oils Demand

Daily Average (1000 bbls.)

	Kerosine	Dist. Fuels	TOTAL
Dec. '52 API*	574	2,025	2,599
Dec. '51 BM	554	1,910	2,464
Change	+20	+115	+135
% Change	3.6	6.0	5.5

*Through December 27

Total (1000 bbls.)
(Bureau of Mines Data)

11 Mos. '52*	114,776	448,256	563,032
11 Mos. '51	113,346	412,587	525,933
Change	+1,430	+35,669	+37,099
% Change	1.3	8.6	7.0

*November estimated from API data

BM Forecast of Heating Oils Demand, 1952
(July 28, 1952; 1000 b/d avg. by quarters)

Estimated		Forecast	
1st Q., 2,398	2nd Q., 1,317	3d Q., 1,281	4th Q., 2,190

Heating Oil Stocks

(1000 bbls. end of month)

	Kerosine	Dist. Fuels	TOTAL
Dec. '52 API*	27,958	103,685	131,643
Nov. '52 API	32,041	117,471	149,512
Oct. '52 BM	33,289	120,721	154,010
Dec. '51 BM	27,088	86,619	113,707

*December 27

Fig. 6—Sharp Increase in Residual Imports

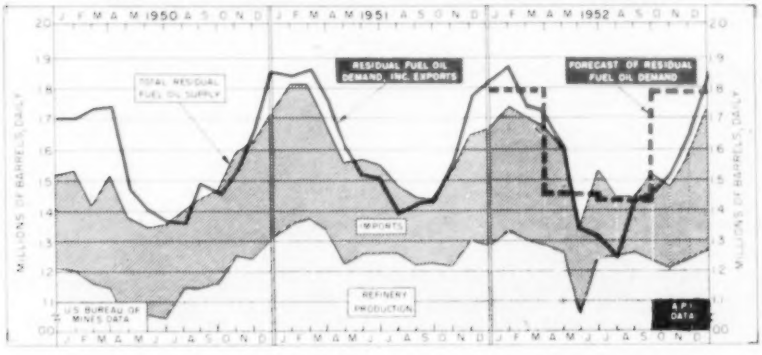
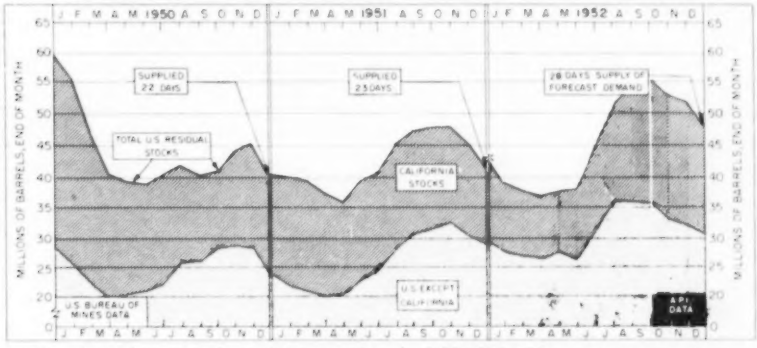

J F M A M 1950 A S O N D
J F M A M 1951 A S O N D
J F M A M 1952 A S O N D
MILLIONS OF BARRELS, DAILY
TOTAL RESIDUAL FUEL OIL SUPPLY
RESIDUAL FUEL OIL DEMAND, INC. EXPORTS
FORECAST OF RESIDUAL FUEL OIL DEMAND
IMPORTS
REFINERY PRODUCTION
U.S. BUREAU OF MINES DATA
API DATA

Fig. 7—Residual Stocks Below 50,000,000 Bbls.


J F M A M 1950 A S O N D
J F M A M 1951 A S O N D
J F M A M 1952 A S O N D
MILLIONS OF BARRELS, END OF MONTH
SUPPLIED 22 DAYS
SUPPLIED 25 DAYS
28 DAYS SUPPLY OF FORECAST DEMAND
TOTAL U.S. RESIDUAL STOCKS
CALIFORNIA STOCKS
U.S. EXCEPT CALIFORNIA
U.S. BUREAU OF MINES DATA
API DATA

***New basis for reporting added approximately 1,500,000 bbls. to primary stocks.**

Residual Fuels Production

Daily Average (1000 bbls.)

	Refinery Output	Imports	TOTAL
Dec. '52 API*	1,271	460	1,731
Dec. '51 BM	1,313	388	1,701
Change	−42	+72	+30
% Change	3.2	18.5	1.8

*Through Dec. 27

Total (1000 bbls.)
(Bureau of Mines Data)

11 Mos. '52*	412,878	112,020	524,898
11 Mos. '51	428,684	106,635	535,319
Change	−15,806	+5,385	−10,421
% Change	3.7	5.1	1.9

*November estimated from API data

Residual Fuels Demand

Daily Average (1000 bbls.)

Dec. '52 API*	1,860
Dec. '51 BM	1,826
Change	+34
% Change	1.9

*Through Dec. 27

Total Demand (1000 bbls.)

11 Mos. '52*	521,268
11 Mos. '51	536,096
Change	−14,828
% Change	2.8

*November estimated from API data

BM Forecast Residual Fuels Demand, 1952
(July 28, 1952; 1000 b/d avg. by quarters)

Estimated: 1st Q., 1,597; 2nd Q., 1,456; 3d Q., 1,424. Forecast: 4th Q., 1,794

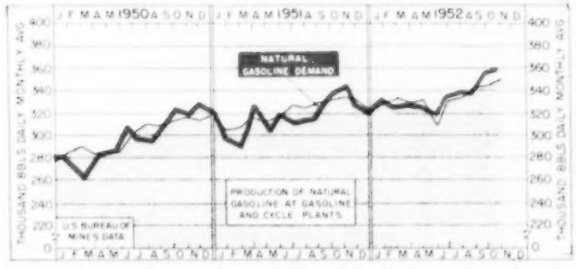
Residual Fuel Stocks

1000 bbls. end of month

	U.S. Except California	TOTAL U.S.
Dec. '52 API*	30,780	48,662
Nov. '52 API	32,833	52,152
Oct. '52 BM	33,559	53,052
Dec. '51 BM	29,605	42,853

*Dec. 27

Fig. 8—Supply and Demand of Natural Gas Liquids


J F M A M 1950 A S O N D
J F M A M 1951 A S O N D
J F M A M 1952 A S O N D
THOUSAND BBLS DAILY MONTHLY AVG.
NATURAL GASOLINE DEMAND
PRODUCTION OF NATURAL GASOLINE AT GASOLINE AND CYCLE PLANTS
U.S. BUREAU OF MINES DATA

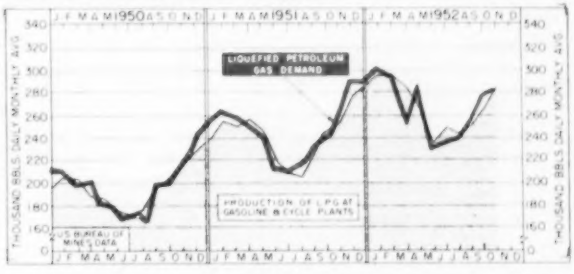
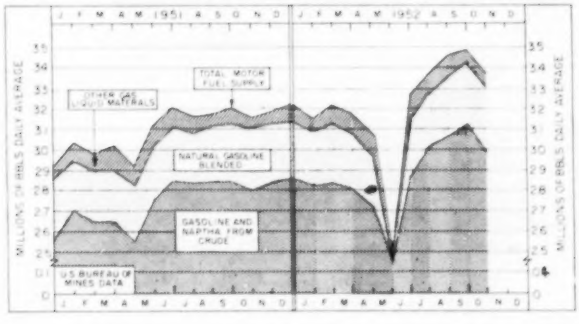

J F M A M 1950 A S O N D
J F M A M 1951 A S O N D
J F M A M 1952 A S O N D
THOUSAND BBLS DAILY MONTHLY AVG.
LIQUEFIED PETROLEUM GAS DEMAND
PRODUCTION OF LPG AT GASOLINE & CYCLE PLANTS
U.S. BUREAU OF MINES DATA

Fig. 9—Makeup of U.S. Motor Fuel Supply


J F M A M 1951 A S O N D
J F M A M 1952 A S O N D
MILLIONS OF BBLS DAILY AVERAGE
TOTAL MOTOR FUEL SUPPLY
OTHER GAS LIQUID MATERIALS
NATURAL GASOLINE BLENDED
GASOLINE AND NAPHTHA FROM CRUDE
U.S. BUREAU OF MINES DATA

(Figures in table in 1000 bbls./day average)

	Gasoline & Naphtha from Crude	Natural Blended	Other Gas Liquid Materials	Total Motor Fuel Supply
Oct. '52*	2,986	315	171	3,583
Sept. '52	3,122	306	71	3,499
Aug. '52	3,088	288	89	3,465
Oct. '51	2,805	301	72	3,178

Natural Gas Liquids Statistics

(Source: U. S. Bureau of Mines Report on Natural Gasoline and Cycle Plant Operations)

	Supply* (1000 bbls./day avg.) Natural Gasoline	LPG	TOTAL	Demand** (1000 bbls./day avg.) Natural Gasoline	LPG	TOTAL
Oct. '52*	350	286	636	355	279	634
Oct. '51	331	253	584	339	256	595
Change	+19	+33	+52	+16	+23	+39
% Change	5.7	13.0	8.7	4.7	9.4	6.6
	Total Supply (1000 bbls.)			Total Demand (1000 bbls.)		
10 Mos. '52	101,492	81,504	182,996	101,717	79,884	181,601
10 Mos. '51	97,074	71,367	168,441	95,676	70,611	166,287
Change	+4,418	+10,137	+14,555	+6,041	+9,273	+15,314
% Change	4.6	14.3	8.5	6.3	13.1	9.2

Stocks, End of Month (1000 bbls.)

	By type of product (At gasoline plants and terminals only) LPG	Natural Gasoline	Condensate	Finished Gasoline†	By Location: Gasoline Plants	Refineries	Total
Oct. '52	2,892	2,599	263	1,185	6,739	2,151	8,890
Sept. '52	2,661	2,587	294	1,117	6,659	2,267	8,926
Aug. '52	2,805	2,858	261	1,162	7,086	2,636	9,722
July '52	2,747	2,738	259	1,134	6,878	3,217	10,095

*Supply includes receipts from refineries as well as current production from natural gasoline and cycling plants. Receipts from refineries in October included 163,000 bbls. of natural gasoline and 1,000 bbls. of naphtha.

**Demand does not include liquefied refinery gases produced for fuel and chemical purposes, which totaled 2,688,000 bbls. in October.

†Includes naphtha and other products.

ADVERTISERS' INDEX

FOR INFORMATION ON ANY PRODUCT OR SERVICE ADVERTISED IN THIS ISSUE SEE INSTRUCTIONS BELOW

Each advertiser listed in this index has been assigned a code letter for use by the reader in securing additional information about advertised products or services which interest him. This code letter appears in parentheses to the left of the advertiser's name.

●

Circle the code letter on the "Advertised Product Inquiry" card (on the page opposite) which corresponds to that assigned the advertiser about whose product you want further information.

Fill in your name, title, company and mailing address and mail the card . . . no postage is required.

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(A-2) AIR PREHEATER CORP. 108
(A-3) AIR PRODUCTS, INC. 104
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(J-1) WESTINGHOUSE ELECTRIC CORP. 29
(J-2) WOLVERINE TUBE DIVISION, CALUMET & HECLA, INC. 140
(J-3) WORTHINGTON CORP. 27
(J-4) WYATT METAL & BOILER WORKS ..... Outside Back Cover
(J-5) YARNALL-WARING CO. 43
(J-6) YORK CO., INC., OTTO H. 96
(J-7) YOUNG RADIATOR CO. 14

Use these cards

to secure information on products and services advertised in *Petroleum Processing* or reviewed in its "*What's New*" section.

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Check the Advertiser's Index for advertisement's code letter. Then circle the corresponding code letter on the card below.

FOR "WHAT'S NEW" PRODUCT INFORMATION:
Circle the code number on the card below which corresponds to the number listed at the end of that specific "What's New" item.

THEN:
Fill in your name, position, company and mailing address. Mail the card . . . no postage is required.

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Issue of January, 1953

For information on "WHAT'S NEW" ITEMS, circle the appropriate code number here.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
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A2	B2	C2	D2	E2	F2	G2	H2	I2	J2	K2	L2	M2	N2	O2	P2
A3	B3	C3	D3	E3	F3	G3	H3	I3	J3	K3	L3	M3	N3	O3	P3
A4	B4	C4	D4	E4	F4	G4	H4	I4	J4	K4	L4	M4	N4	O4	P4
A5	B5	C5	D5	E5	F5	G5	H5	I5	J5	K5	L5	M5	N5	O5	P5
A6	B6	C6	D6	E6	F6	G6	H6	I6	J6	K6	L6	M6	N6	O6	P6
A7	B7	C7	D7	E7	F7	G7	H7	I7	J7	K7	L7	M7	N7	O7	P7
A8	B8	C8	D8	E8	F8	G8	H8	I8	J8	K8	L8	M8	N8	O8	P8
A9	B9	C9	D9	E9	F9	G9	H9	I9	J9	K9	L9	M9	N9	O9	P9

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33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
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For information on ADVERTISED PRODUCTS, circle the appropriate code letter here.

A1	B1	C1	D1	E1	F1	G1	H1	I1	J1	K1	L1	M1	N1	O1	P1
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A9	B9	C9	D9	E9	F9	G9	H9	I9	J9	K9	L9	M9	N9	O9	P9

Name (Please Print) _____ Position _____

Company _____ Business Address _____

City, Zone _____ State _____

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FOR MORE INFORMATION...

about products and services advertised in this issue of Petroleum Processing or reviewed in its "What's New" section, use the postage-free cards provided below.
(See other side for complete instructions.)

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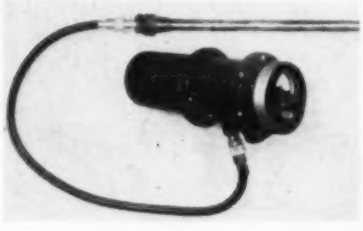
CLEVELAND 13, OHIO

WHAT'S NEW . . .

TOPS in WHAT'S NEW—1952

Note: Items 1 through 16 for this month's "What's New!" will be found on pages 60-61 of this issue. They are repeat reviews of the equipment, products, and literature and most interesting to PETROLEUM PROCESSING's readers during the past year. As a service to those who may have missed them or who may now find them of value, these items have been reviewed again this month. They have also been given code numbers which can be used on the regular Reply Card.



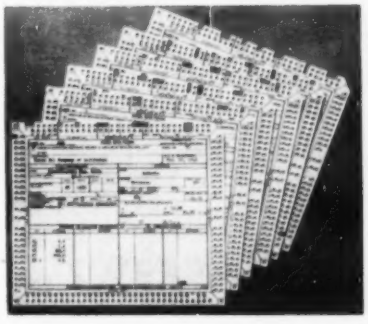
New Electronic Level Control Developed for Non-conductives

. . . ranging from condensed gases to semi-solids. The "KTrol" is a small, compact unit with plug-in, sealed housing containing all components. Exchangeable sealed component units are available for insertion without disturbing or removing the equipment from the tank. Level control is maintained from $\pm \frac{1}{16}$ in. and up. Probes are made in corrosion-resistant materials for various conditions and are designed for the kind and size of tank to be used. Unit is unaffected by humidity or temperature. It operates from a standard light circuit. Current used in the control circuit is equal to or less than that in a thermocouple. Greylor Co., 605 West Washington Blvd., Chicago 6, Ill.

Circle No. **17** *on Reply Card*

For More Information

Use one of the attached reply cards to request additional details or literature on any items reviewed in "What's New!" Just circle the numbers corresponding to the numbers at the end of each item in which you are interested. Then fill in the rest of the card and drop it in the mail. No postage required.



Punchcards Speed up Identifying Compounds by Mass Spectra

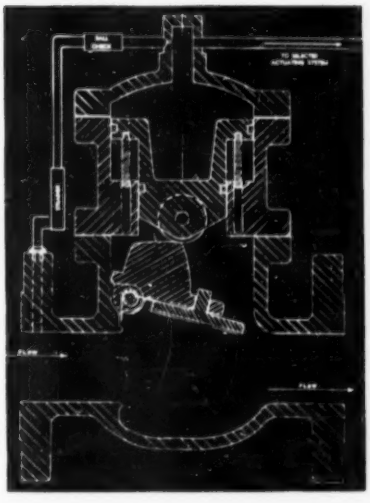
. . . in new "Keysort File" system. The cards mechanize the process of comparing recorded spectra with known mass spectral data, thus eliminating a laborious, time-consuming step in data interpretation. Form used in the printed cards is substantially that adopted by the API in its Mass Spectral Data Catalog, with the sensitivity on each card adjusted to a standard level for ease in calculation. Thus, work already accomplished by others need not be duplicated. Data on 550 distinct compounds is readily available. Each card provides four fields of selection by a needle-sorting method, in which one or several needles may be inserted in the holes representing the desired information. Edges of the cards are slotted on the basis of 1) molecular wt., 2) boiling pt., 3) presence of various elements, and 4) ion mass, with between 3 and 8 peaks punched per spectrum. In addition to the data in the form of slots for use in initial selection and separation, each card bears the complete mass spectrum of its compound, showing all peaks whose relative intensities (the largest peak being considered 100%) are 0.46 or greater. Other information on the card includes: the instrument on which the spectrum was determined, date, place, source of sample, molecular and semi-structural formulae, and pertinent instrument settings and test conditions. Consolidated Engrg. Corp., 300 N. Sierra Madre Villa, Pasadena 8, Calif.

Circle No. **18** *on Reply Card*

Alarm System Warns Against Excessive Flow in Pipelines

. . . for use in process equipment. The "Max-Alarm" will operate a visual or audible signal, or also shut off a pump or close a motorized valve when the maximum limit has been exceeded. The sensing unit is unaffected by pressure variations in the measured fluid and can be used at pressures up to 20,000 psi., and temperatures from 4° Absolute to 1200° F. The system can be used with toxic or highly corrosive liquids, viscous fluids, and many other hard-to-handle liquids. One signal light on the panel indicates when the instrument is operating. A second light flashes only when the flow rate is exceeded. A reset button permits turning off the warning light and resetting the alarm relay. Price is in the $400 range and units are available 90 days after receipt of order. Potter Aeronautical Co., 87 Academy St., Newark, N. J.

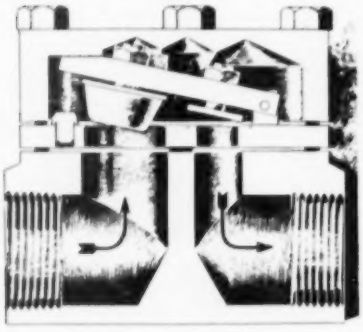
Circle No. **19** *on Reply Card*

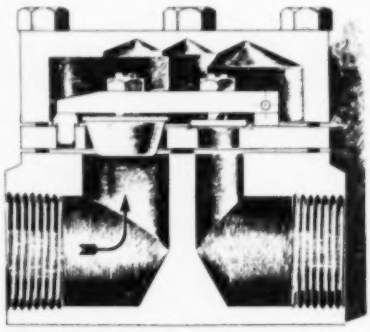


Piston Actuates Quick-opening Valve for Fire Control Systems

. . . or other emergencies in petroleum plants. Uses range from opening water into quench lines, sprinkler, spray, or fog systems, to dumping process vessels to outside storage in times of plant fire. The new Sentry piston valve is said to be particularly adaptable to better protection against propane and butane fires. Valve disc is faced with vulcanized, especially prepared Hycar for positive closure. Quick action is assured through line pressure exerting full force on the disc, forcing the valve to open position when piston pressure is released. Any number of the valves may be operated from one set of controls. They may also be closed by remote control and may be operated manually or in combination with fire-fused seals, pneumatic controls, or open or closed circuit solenoid. Valves may be installed in any position in the line, from full right side up to full right side down. Standard valves in the series are rated at 250 psi. The McRae Corp., 621 So. Spring St., Los Angeles, Calif.

Circle No. **20** *on Reply Card*





Small Traps Have High Capacity

. . . making them applicable to petroleum processing equipment. The new Series 50 "Yarway" Impulse Steam Trap has proved successful for condensate drainage on heat exchangers and stage heaters, reheaters, reboilers, stills, debutanizers, polymerization and gas stabilization units, etc. An example of the maximum capacity is 17,300 lb. of condensate per hr. for the 1½-in. size trap at 100 psig., based on condensate 30° F. below steam temperature. Basic operating principle is same as that of Series 60 and 120 traps. A hinged lever and two valves are mounted on a valve seat plate. The control flow which governs the opening and closing action of the valves is obtained by allowing small clearance between inlet and outlet valves and their respective seats when the lever is at rest. The small size and light weight of the traps makes them useful where close quarters piping is involved. The 1½-in. size measures 5½ in. long x 5 in. high x 2/3 in. wide, and weighs 14½ lb. Yarnall-Waring Co., Philadelphia 18, Penna.

Circle No. **21** *on Reply Card*

Dissolved Oxygen Contents Can Be Obtained in 10-30 Seconds

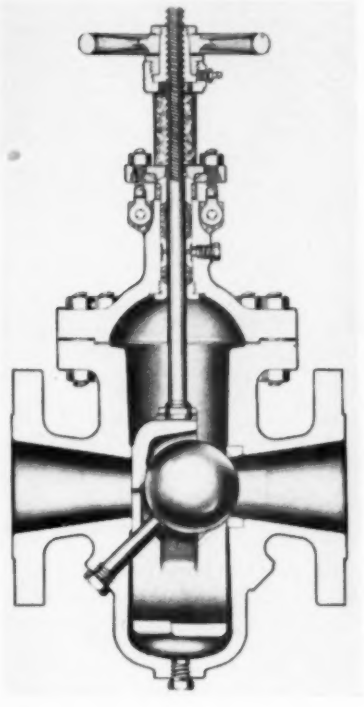
. . . with the new Dorber Portable Analyzer for aqueous solutions. The unit is not subject to interference by dissolved iron, calcium, magnesium, or organic matter, as is the case with the usual Winkler test. It is said to be suited for field use in checking the oxygen content of sewage or brines, or in the laboratory on chemical processes. Entirely self-contained in a cabinet, 22 x 11 x 7 in., the instrument uses readily obtainable batteries. It uses an amperometric principle in which minute traces of dissolved oxygen are reduced at a rotating platinum cathode. The electrode assembly is built on a detachable frame that can be used for other analyses if desired. Sample to be analyzed is placed in a plastic container which is then attached to the instrument. This provides a meter reading which is converted to ppm. of dissolved oxygen by means of a calibration chart. Determinations correct with 5% for most solutions can be made in 10 to 30 seconds. Deliveries are running about two to four weeks from date of order. Price is less than $500. Dorber Co., 7741 West Palatine Ave., Chicago 31, Ill.

Circle No. **22** *on Reply Card*

Lab Mixer Has Fixed Motor And a Movable Propeller

. . . for faster stirring operations. The "Hollow Spindle" Laboratory Stirrer, with a propeller that can be raised or lowered permits the operator to: 1) vary its working length according to the size of vessel employed, and 2) place and remove containers by raising the propeller only. The spindle is actually the motor armature with a 5/16-in. chuck at one end and a centering device at the other. The sparkless, 1550 rpm., shaded pole motor develops a torque of 5.195 inch-ounces. Power line enters the motor through a ½ x 9 in. tubular support arm. An on-off, feed-through switch in the 7-ft. cord controls the current. Stirrer operates on 115-volt, 50-60 cycle A.C.: power consumption, 45 watts. Eberbach Corp., Ann Arbor, Mich.

Circle No. **23** *on Reply Card*



New Venturi Ball Valve Design Has Accurate Flow Control

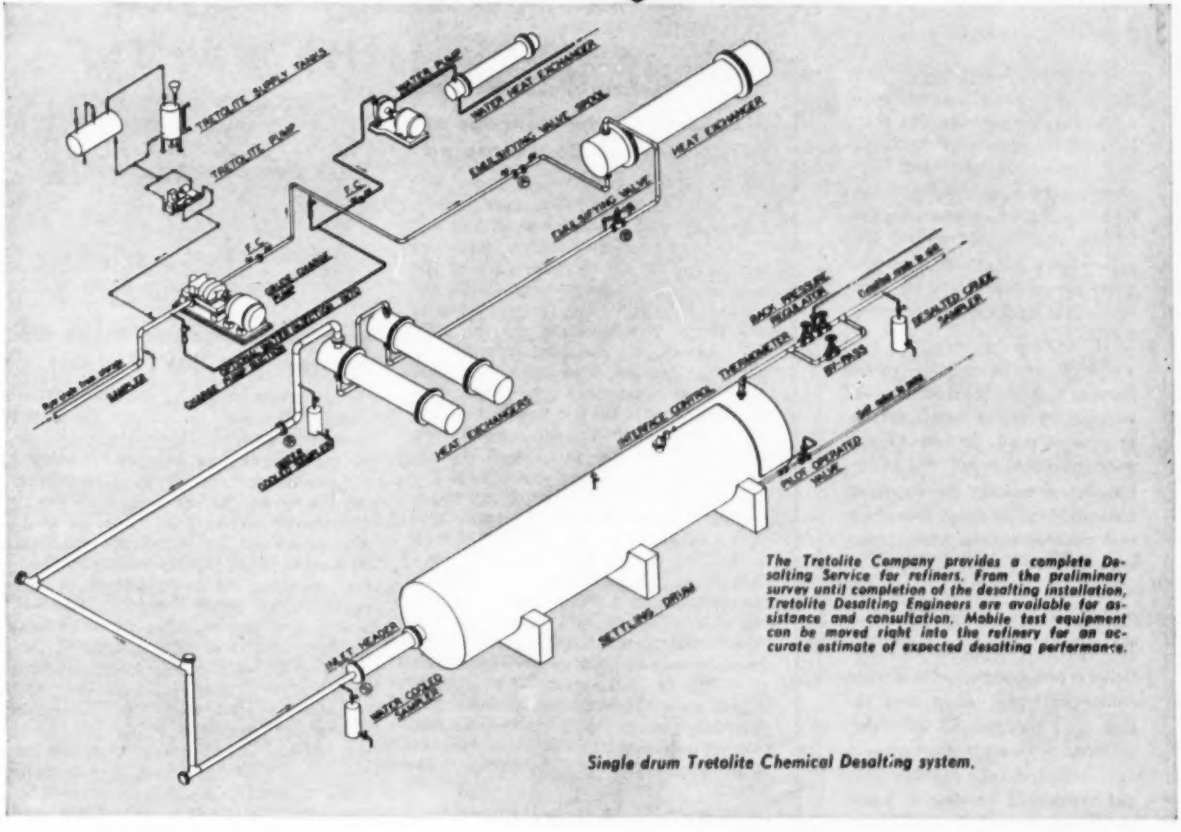
. . . with a minimum of wire-drawing. The ball is not attached directly to the valve stem, but rides in a cage which is attached to the stem by a tee-head slotted construction. In operation, the ball is moved to and from the center of flow, and rolls into and out of the body seat. The ball disc is mechanically locked in the closed position by a wedging member on the cage. In moving to the fully open position, the ball rolls out of the seat and up, until it is lined up vertically with the stem and is carried out of the path of flow. The design provides straight-through flow with much lower pressure drop than that through a globe valve; absolutely tight shut-off; easy operation; and freedom from vibration or chattering, regardless of position of the ball disc. The valves are available in venturi patterns, with flanged ends, in cast carbon steel and Crane 18-8 Mo. alloy steel, and in a wide range of sizes beginning at 1-in. Cast steel valves are available in 150, 300, and 600-lb. classes: alloy valves in 150 and 300-lb. Crane Co., 836 So. Michigan Ave., Chicago 5, Ill.

Circle No. **24** *on Reply Card*

TRETOLITE DESALTING

UTILIZES CONVENTIONAL REFINERY EQUIPMENT

Examine the flow diagram below, note the equipment required. Every item is conventional, already available in most refineries. A Tretolite Desalting plant often can be assembled from existing refinery equipment, thereby holding installation costs at minimum.



The Tretolite Company provides a complete Desalting Service for refiners. From the preliminary survey until completion of the desalting installation, Tretolite Desalting Engineers are available for assistance and consultation. Mobile test equipment can be moved right into the refinery for an accurate estimate of expected desalting performance.

Single drum Tretolite Chemical Desalting system.

A recent survey of Tretolite Desalting installations disclosed that Tretolite is now desalting over 1,000,000 barrels per day, with an average salt-removal percentage of 95, at an average cost per barrel of 2.5 mills.

For complete information on Tretolite Desalting, write or call the

TRETOLITE COMPANY

TD 52-2

JOHNSON
Right Angle
GEAR DRIVE

Offers Wide and Varied Application in the Petroleum Industry

The Johnson Right Angle Gear Drive has a wide application in oil and gas industries. The drive is used by refineries for Cooling Tower installations with steam turbine, internal combustion, or electric prime movers. In the vicinity of natural gas pipe lines many gas engine gear drives are in use for farm irrigation and municipal water supply.

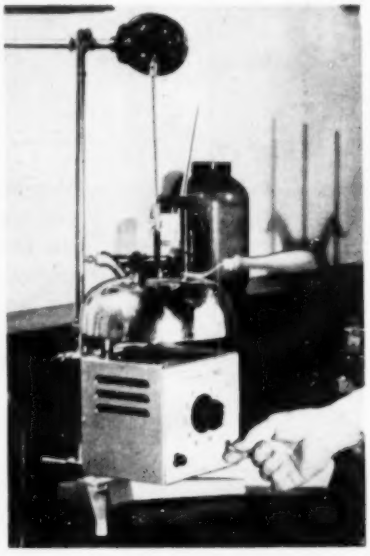
Vertical or horizontal prime movers can be used with equal success in many applications. The advanced design of the Johnson Drive meets the exacting requirements of exposed operation . . . assures maximum service and safety with utmost economy and dependability . . either for standby, emergency or continuous 24 hour service.

The Johnson Right Angle Gear Drive is manufactured in a wide range of types, sizes and ratios . . . adaptable for dual, multiple or combination operation. Thousands in use throughout the world serving industry at low-operating cost and high efficiency. Catalog and full engineering data on request.

JOHNSON GEAR & MANUFACTURING CO.
8th & Parker Streets., Berkeley 10, Calif.
Please send Catalog and Engineering Data

Firm_____
Individual_____
Street_____
City_____ State_____

What's New!



Flash Point Tester Redesign of Pensky-Martens Closed-cup unit

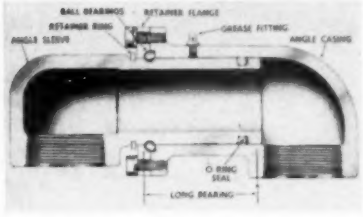
. . . to meet new petroleum and petrochemical needs. The new Fisher/Tag model, available in both gas and electrically-heated versions, now has the heater as an integral part of the assembly. All other components are mounted on the same tripod support for simple transporting. On the electric model, a variable transformer permits precise heat input control. Heater is cast into the unit that forms the air bath, eliminating the strap-on heater. The cup cannot tip when set on the laboratory bench, and has a wood grip riveted to the handle for slip-proof handling. Both models are furnished with electric motors, connected to the stirrer through a flexible shaft. Both have an "eccentric cam" assembly for dipping the test flame at the exact moment the shutter opens. A bead of the specified size is provided for the comparative adjustment of the test flame to 5/32 in. diameter. The electric model uses 115 volt, 50-60 cycle AC. Stirring motors on both models use the same current. Fisher Scientific Co., 717 Forbes St., Pittsburgh 19, Penna.

Circle No. **25** *on Reply Card*

New Water Treatment Designed For Boilers under 400 psi.

. . . is a concentrated neutral liquid obtained by caustic extraction from waste wood of Western Red Cedar. Trade-named "Borgana", this complex mixture of organic compounds is partially colloidal in nature, consisting mainly of dissolved lignins, tannins, and semi-resinous materials. Developed by the chemical division of The Portland Shingle Co., it is non-toxic internally and externally, and is non-injurious to metals, gaskets, or packing materials. Complete boiler treatment can be obtained, it is said, by adding approximately one quart of Borgana per 100 boiler hp. per week. The yearly cost is stated to be about $1 per boiler hp. No shut-down of boiler equipment is required. The material is added to boiler or make-up water once a week. Its action is detergent. It penetrates between layers of scale and loosens deposits materials. Its action is slow, preventing possible plugging. Normally, 30 to 90 days are needed to dissolve old scale and clean up a boiler. Borgana is being sold with an unconditional guarantee. The purchase price will be refunded to any user after a 60-day test if it does not solve his boiler problems to his complete satisfaction. It is being distributed nationally by Strong, Carlisle and Hammond Co., Cleveland 13, Ohio.

Circle No. **26** *on Reply Card*



Lubricated Swing Joint Has Ball Bearings that Can't Fall Out

. . . when it is taken apart. New design features a long, lubricated bearing which provides adequate support for piping as well as the means for positioning the ball bearings. Sealing is by an "O" ring in a recess in the sleeve of the joint. Special rings are provided for handling gasoline, fuel oil or other liquids without softening, swelling or deterioration at any temperature from −30 to +250° F. Joints are also suitable for pressures as high as 1500 psi. hydraulic, depending on size and service. Offered in steel for refinery, railroad, and other heavy duty service, the joints are being produced in eleven different styles, including counter balance and double swing styles, and in four sizes, 2, 2½, 3, and 4 in. Barco Mfg. Co., Dept. J-20, 1801 W. Winnemac Ave., Chicago 40, Ill.

Circle No. **27** *on Reply Card*

Did You Miss "Did You Miss?"

Because the feature "Tops in 'What's New!'—1952" appearing in this issue on pages 60-61 *provides the reader with the same kind of service that the regular monthly "Did You Miss These?" provides, the latter has been omitted from this issue. Watch for it next month.*

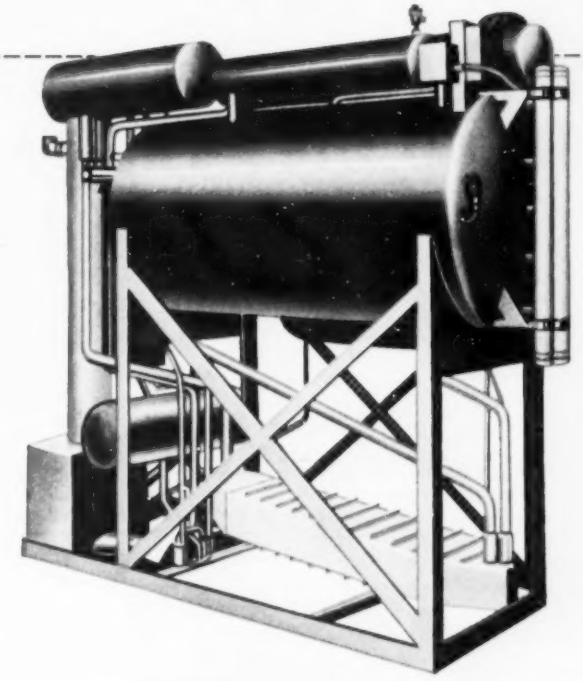
Solve cooling problems with waste heat or low-cost steam!

FLEXIBLE

SERVEL

WATER CHILLER

meets all 3 cooling needs

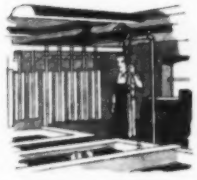


5-YEAR WARRANTY! Every Servel 25-ton Water Chiller is backed by a full 5-year warranty. Because it has no moving parts, the Servel Water Chiller operates quietly and without vibration. Add to these advantages its extremely compact size and light floor weight and you'll appreciate why it can be installed on any floor with most economical piping arrangement. May be installed singly or in multiple as required. Mail the coupon below today for complete information.

1. AIR CONDITIONING

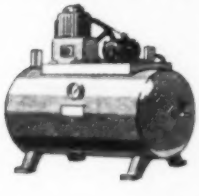
The adaptable Servel 25-ton Water Chiller—operating on any source of steam—uses water as the refrigerant to provide economical temperature and humidity control in large buildings and factories. No expensive duct systems are required!

2. PROCESS COOLING



Because it operates with no moving parts on the time-proved absorption refrigeration principle, you can depend upon the Servel 25-ton Water Chiller for continuous high-efficiency cooling of liquids for various manufacturing and formulating processes.

3. INDUSTRIAL PRECOOLING



You can use the unusually flexible Servel 25-ton Water Chiller to precool air for increased capacity and improved performance of air compressors and internal combustion machines. The Water Chiller also serves other money-saving precooling purposes.

Servel

the name to watch for great advances in . .

AIR CONDITIONING ✓ REFRIGERATION

MAIL THIS COUPON TODAY

SERVEL, INC., Dept. PP-1, Evansville 20, Indiana

Please send me further information about application flexibility of the Servel 25-ton Water Chiller.

Name _____

Firm _____

Address _____

City _____ Zone _____ State _____

(*To obtain more data on advertised products see page* 128)

TRADE PAPER EDITION
Published by
SCHUTTE and KOERTING
Company

ENGINEERING

JET APPARATUS • HEAT TRANSFER EQUIPMENT • STRAINERS • CONDENSERS AND VACUUM PUMPS • OIL BURNING EQUIPMENT • ROTAMETERS • FLOW INDICATORS • RADIAFIN TUBES • VALVES • SPRAY NOZZLES AND ATOMIZERS • GEAR PUMPS • DESUPERHEATERS

VERSATILE JET EDUCTORS BLEND OILS THE EASY WAY

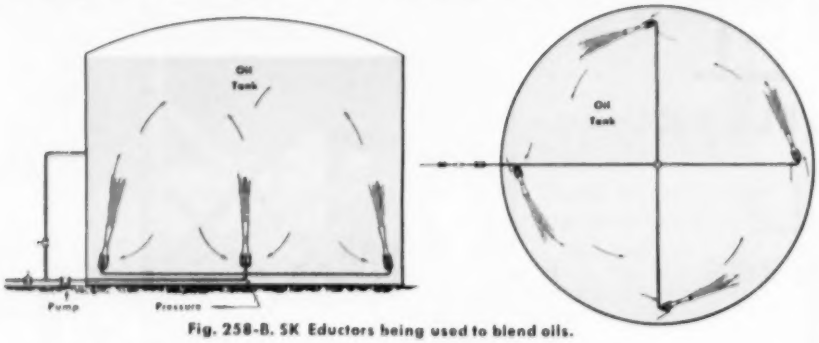


Fig. 258-B. SK Eductors being used to blend oils.

Applications of SK Jet Eductors include lifting, pumping, mixing, and agitating of liquids and the handling of solids and slurries.

Specifically, in the petroleum industry, they are currently being used in pumping and mixing operations in oil treating systems (such as sweetening-alkylation), for introducing anti-knock fluids and coloring matter into gasoline, and for continuous blending, acidifying, causticizing of oils, for removing spent filter clay, and for tank mixing and proportioning operations.

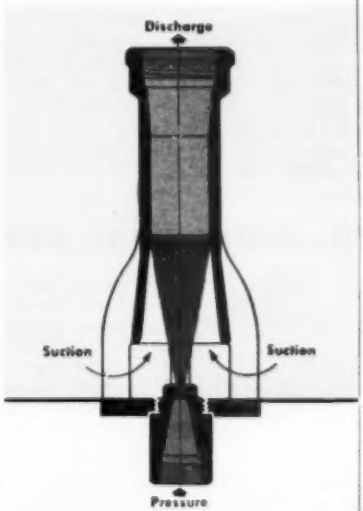
In all of these operations, jet eductors provide certain definite advantages—based, to a great extent upon the fact that they are simple in design and construction, require little maintenance or supervision and yet are very efficient.

A typical application is shown in Fig. 258-B. Here, five 8″ SK Fig. 258 Internal Mixing Eductors are being used to blend, recirculate and agitate oils in a 100 ft. tank. Initially, transfer pumps are used to fill the tank through the eductors. As soon as the liquid submerges the eductor nozzle, blending begins. In this particular instance, the eductors are arranged to entrain 3 gallons of tank oil for each gallon of motive oil. Other ratios are possible.

As shown by the sectional drawing, Fig. 258, motive oil, under pressure, issues from the eductor nozzle and entrains oil from the tank. The two are thoroughly mixed in the eductor throat and are then discharged. After the tank is full, the mixing is completed and stratification is prevented by using the pump to recirculate oil from the top of the tank through the eductors where oil from the bottom of the tank is again entrained.

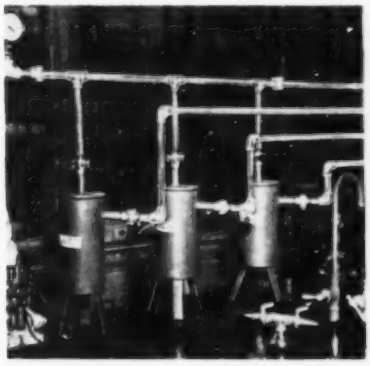
This illustrates but one of many uses for only one of many types of SK Jet Eductors. For other interesting examples of how eductors can be applied, request a copy of Bulletin 2-M.

Fig. 258. Photo and sectional view of an SK Internal Mixing Eductor.



SCHUTTE and KOERTING Company

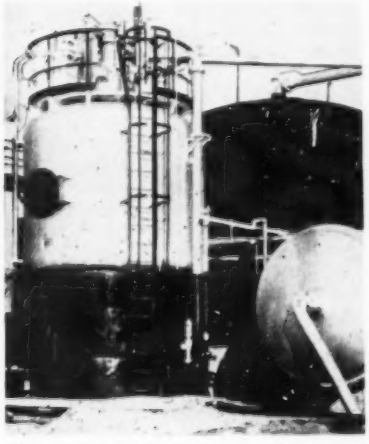
35 CORNWELLS HEIGHTS
BUCKS COUNTY, PA.
Representatives In Principal Cities



Plastic Piping for Lab Permits Operator to "Watch" Processes

. . . because it's made of transparent, cellulose acetate butyrate. Available in sizes from ½ to 4 in., it is also adaptable to bench scale or pilot plant work. Called "Mills III," it has high resistance to corrosion and other forms of chemical attack. Sections can be joined by a solvent cement that produces a leakproof, homogeneous bond. Sizes up to 2 in. have a working pressure of 100 psi. at 100° F. Although semirigid, it is flexible enough to permit broad radius bends and considerable misalignment. No threading or special tools are required, even where connecting to standard steel pipe and fittings. Ordinary hand saws will cut the material. Full line of "Milex" plastic fittings is available, including flange unions and flange adapter unions for joining to steel, etc. Elmer E. Mills Corp., 2930 North Ashland Ave., Chicago 13, Ill.

Circle No. **28** *on Reply Card*



New Electric Process Developed For Treating, Distillate Stocks

. . . with acid, alkali, doctor, or similar chemicals. It is designed to provide continuous, automatically-controlled treating with predictable results. Comparatively small amount of equipment and ground space is re-

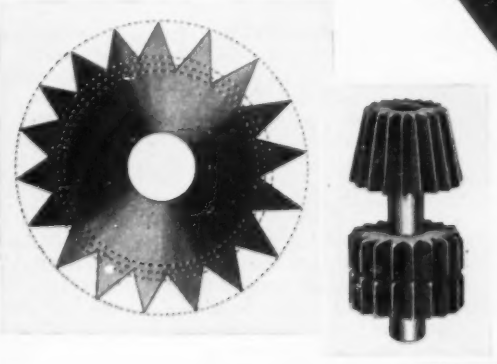
One of many reasons why skilled refinery workmen prefer

AIRETOOL TUBE CLEANERS

heads that really clean

This Airetool double expansion head is excellent for removing extremely heavy or uneven coke deposits. The offset cone cutter dislodges hard deposits and the double expansion cutter cleans out the remaining coke.

There's no foreign deposit, in any size tube, straight or curved that can't be quickly and completely removed by one of the many AIRETOOL tube cleaner heads. Precision made of special heat treated alloy steels, these AIRETOOL heads clean out even the hardest deposits, and restore tubes to their original efficiency. They are constructed with a minimum of parts for easy maintenance, and can be used with a variety of powerful motors for rapid, thorough tube cleaning. The versatility, variety and efficiency of AIRETOOL tube cleaner heads are basic reasons why they can improve your tube maintenance program. For full details, write to: The AIRETOOL Mfg. Co., 336 S. Center St., Springfield, O.



Airetool cleaner heads feature New Form Cutters designed to eliminate tracking in tube walls. They have variable pitched, milled teeth, and will rapidly and thoroughly clean every known size and type of oil refinery tube.

There's an Airetool Tube Cleaner and Tube Expander for Every Type of Tubular Construction.

AIRETOOL MANUFACTURING COMPANY

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BRANCH OFFICES: Philadelphia • New York • Chicago Tulsa • Baton Rouge • Houston • Hudson Heights (N.J.)
REPRESENTATIVES in principal cities in U.S.A., Canada, Mexico, South America, England

(To obtain more data on advertised products see page 128)

solves your extraordinary corrosive pumping problems

extra CORROSION ALLOWANCE . . . All Pacific Process Pumps are custom-built with the case casting thickness in excess of the actual pressure-temperature requirements. This provides a liberal allowance for corrosion-erosion and a high safety factor.

extra HEAVY CONSTRUCTION . . . Pumps are developed to combine the strength necessary for continuous heavy duty service with the simplicity and accessibility for low maintenance cost. All parts in contact with pumped liquid may be fabricated from any commercially available ferrous or non-ferrous metal.

extra CAPACITY . . . Types SVC and SEC single-stage Process Pumps handle liquids from sub-zero to 800°F.; 15 to 1600 gpm; 500 to 600 psig pressure; heads up to 600 feet; speeds to 4,000 rpm. Type RVC two-stage Process pumps handle liquids from sub-zero to 850°F.; to 600 psig pressure; heads to 825 feet; speeds to 3,600 rpm. All 3 types available with suction diameter from 1½" to 8"; discharge diameters from 1" to 6".

Write for Bulletins 101 and 108

Pacific Pumps inc.
ONE OF THE DRESSER INDUSTRIES

PACIFIC Precision Built PUMPS

HUNTINGTON PARK, CALIFORNIA

Export Office: Chanin Bldg., 122 E. 42nd St., New York
Offices in All Principal Cities

CP-3

What's New!

quired; the treater usually is not larger than 10 ft. in diameter. Additional equipment such as pumps, tanks, filters, centrifuges, and the like, is in many cases virtually eliminated, according to the manufacturer. The process can be applied to such stocks as naphtha, gasoline, kerosine cat-cracker charge, cat-cycle oils, diesel fuel, and furnace oil. The thereby preventing the escape of fumes or air pollutants. Electric power requirements are said to be within the normal capacity of the usual refinery power supply. Two refiners have already made commercial application of the process with satisfactory results. A California installation is an acid treating plant, primarily for the desludging of cracked gasoline. A Kansas installation is a doctor-treater. Precise control of the process, coupled with intimate contacting between distillate and treating agent is said to result in less chemical used per bbl. of oil treated. Action is fast, assuring a quick break and complete separation. In acid treating, the amount of acid sludge formed is reduced, and the sludge is suitable for re-use or recovery. In caustic treating, emulsion in the caustic effluent is eliminated: in doctor treating, no black-strap is formed. Petrolite Corp., Petroco Div., 5515 Telegraph Rd., Los Angeles 22, Calif.

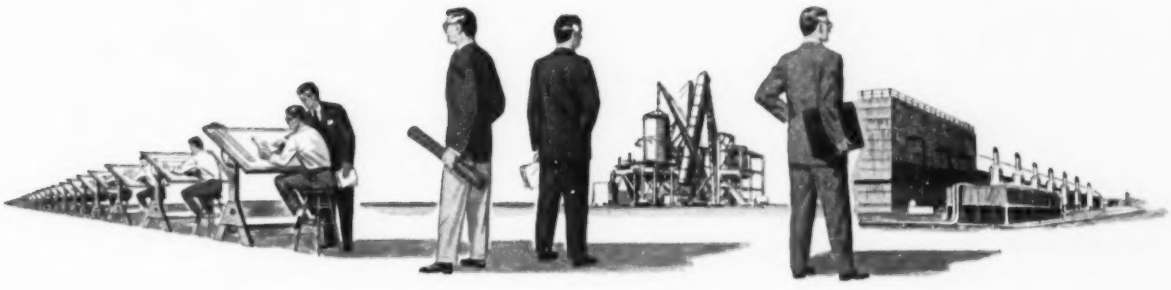
Circle No. **29** *on Reply Card*

Recorder Operation Safer When Chart Drive Is Pneumatic

. . . and is sealed with a plastic cover to keep out dust and other foreign particles. Developed for use with the "Tel-O-Set" line of recorders, the "Macnick" chart drive has three essential components: 1) a sealed escapement mechanism, 2) a gear reduction unit with an impulse wheel, and 3) a two-way clutch assembly. Air supply to the drive mechanism enters through copper tubing connected to the rear of the case, where electrical connection is usually made. An additional 10 in. of flexible rubber tubing permits the drawer-type chassis to be partially withdrawn without breaking the air connection, and permits chart changes. A standard hex wrench adjustment lines up the chart time line with the instrument pen. Air pressures can vary from 20 to 35 psi. without affecting the timing. Air consumption at 20 psi. is 0.080 cfm. Chart speed is one in./hr. A maximum constant torque of 8 ounce-inches is provided at the 20-35 psi. supply pressures. Maximum limit of timing error is ±10 secs./hr. Minneapolis-Honeywell Regulator Co., Industrial Div., Wayne & Windrim Aves., Philadelphia 44, Penna.

Circle No. **30** *on Reply Card*

How would you define **FLUOR**?



An Engineering Firm?

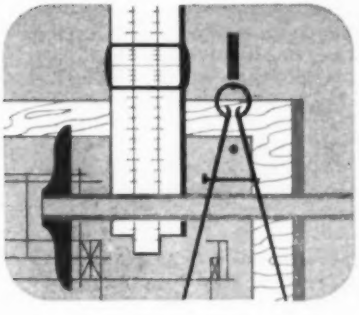
Fluor is an engineering firm capably staffed with over 800 chemical, process, mechanical, electrical, instrument, civil, architectural and hydraulic engineers and draftsmen. Headquarters at Los Angeles and Houston are points of origin for a large variety of engineering services embracing all types of projects in natural gas, petroleum, petrochemical and industrial fields.

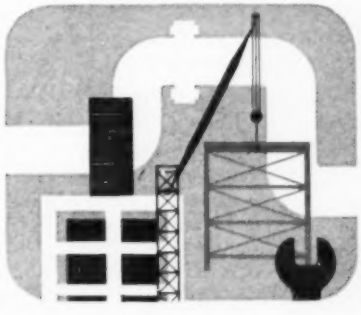
A Construction Company?

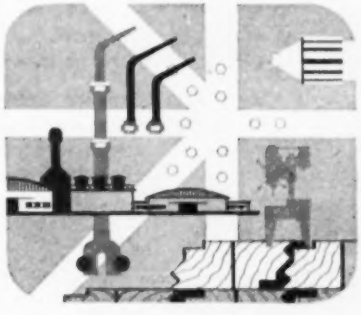
Fluor's Construction Division is permanently staffed with over 250 key men experienced in the erection of plants and facilities both in and out of the United States. This large reservoir of craftsmen assures the availability of competent men for every worldwide project, who work in close cooperation with Fluor's engineering groups and the client's personnel.

A Manufacturer?

Fluor's Manufactured Products Division is a large, completely integrated organization devoted exclusively to the design, development and manufacture of natural draft and mechanical draft cooling towers, air-cooled heat exchangers, pulsation dampeners, mufflers, gas cleaners and special products for industry. Fluor products are in demand the world over.







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FLUOR INTERNATIONAL—BEIRUT
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CHICAGO
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PITTSBURGH
SAN FRANCISCO
HOUSTON
BIRMINGHAM
TULSA

(*To obtain more data on advertised products see page* 128)

PETRONATE*
(Oil Soluble)
PYRONATE*
(Water Soluble)
HYPONATE*
(Oil Free)

PETROLEUM SULFONATES
. . . made to your specifications for use in products such as . . .

- rust preventive formulations
- soluble cutting oils
- soluble textile oils
- emulsion degreasing compounds
- fuel oil additives
- emulsifiers for agricultural and insecticide sprays
- special emulsifying formulations

Ask Sonneborn about PETRONATE, the oil soluble petroleum sulfonate available in various molecular weights; HYPONATE, an oil free petroleum sulfonate; and PYRONATE, a water soluble petroleum sulfonate effective as an emulsion breaking reagent.

Sonneborn petroleum sulfonates—superior in quality and possessing exceptional uniformity—are now made to fit a wide variety of specific needs. They can also be tailor-made to your exact specifications. You can rely upon prompt shipment.

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This valuable booklet gives highly useful data on the many ways PETROLEUM SULFONATES are being and can be used. Write today for this highly informative booklet.

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Achieved by
Sonneborn
RESEARCH

What's New!

Corrosion-resistant Pipe Fittings Made of Polyvinyl Chloride

. . . are standard threaded IPS design. In ¼ to 2 in. sizes, in tees, 45 and 90 ells, and couplings, they can be used with the manufacturer's "Boltaron" plastic pipe. The pipe in sizes to match is available in 10 and 20 ft. lengths and can be threaded with ordinary pipe dies. The polyvinyl chloride is trade-named Boltaron 6200 and is highly resistant to the action of organic and inorganic acids, alkalis, and alcohol. It is an unplasticized, rigid vinyl. H. N. Hartwell & Son, Inc., Box 15, Boston, Mass.

Circle No. **31** *on Reply Card*

How to Operate, Select, And Maintain Steam Traps

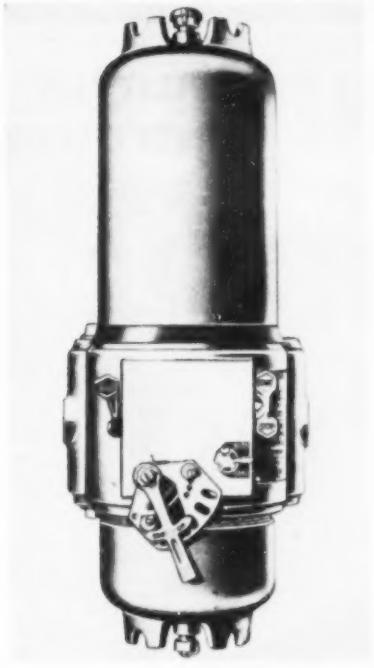
. . . is the subject of "Please Pass the Condensate," a new industrial motion picture. In color and sound, the 20-minute film was prepared with the aim of getting more production from steam-heated equipment through reduced heat-up time, hotter operating temperature, and shortened down-time for repairs and cleaning. First public showing was at the Power Show in New York's Grand Central Palace last month. The picture is now available for showing to engineering and plant groups. Information on prints may be secured from Yarnall-Waring Co., Philadelphia 18, Penna.

Circle No. **32** *on Reply Card*

Thermocouple Connector Uses Fractional Size Tube Fittings

. . . of a compression type, the "Swagelok" design. Thermocouples or dip tubes are easily handled with the new connectors, which are bored completely through at one diameter. They can be furnished in a wide variety of sizes from ⅛-in. up in brass, aluminum, steel, stainless steel, and monel. In an emergency, regular Swagelok connectors can be bored completely through to the required diameter in the user's own shop to accommodate thermocouples. Crawford Fitting Co., 884 East 140th St., Cleveland 10, Ohio.

Circle No. **33** *on Reply Card*



Seven Changes Improve Line Of Electric Motor Controls

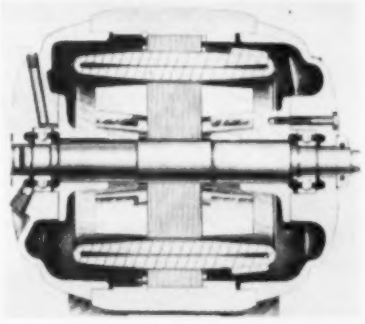
. . . known as Model M52. The new design of explosion-proof line starter and circuit breaker condulets features: 1) built-in pushbutton stations, 2) built-in selector switches, 3) additional back conduit entrances, 4) additional horizontal through-feed conduit entrances, 5) a new reset mechanism, 6) Neoprene gasket to protect upper cover joint in severe weather conditions, and 7) increased wiring space. Known formerly as Type EPC, the equipment retains the use of high density aluminum alloy castings and sectionalized construction which permits even size 4 starters in combination with 200-amp. circuit breakers to be installed without lifting any equipment. Condulets are for all sizes of line starters and combinations up to size 4, and for circuit breakers alone up to 600 amps. Crouse-Hinds Co., Syracuse 1, N. Y.

Circle No. **34** *on Reply Card*

Infrared Gas Analyzer Records One Compound Continuously

. . . in plant process streams. For example, during five years of field testing, it has been applied to measure carbon monoxide in a Fluid catalytic cracking unit regenerator, methane in ammonia manufacture, iso-butane in alkylation units, and many others. Speed of measurement is 10 secs. In one application, it measured CO_2 in nitrogen over a narrow range of 0 to 0.08% CO_2. Results were: a 7-day stability of $\pm 0.001\%$ CO_2; a sensitivity of $\pm 0.0004\%$ CO_2; and a readability within 0.001% CO_2. It is equipped with a range-changing dial: the same design of cell column is used for all measurements, yet various lengths of sample and filter cells can be used for maximum sensitivity. A negative-filtering method permits measurements with high selectivity. Although all compounds in the gas sample stream absorb some of the transmitted radiation, the absorption of background gases either cancels out automatically or is blanketed by a filter cell. Therefore, the difference between the remaining radiation and a radiation "reference" represents only the absorption of the selected gas compound. A differential thermopile produces a corresponding emf which is recorded as % concentration by a Speedomax electronic recorder. The analyzer can be furnished calibrated or uncalibrated, for single or multiple-point recording, for electric or pneumatic control, with explosion-resistant or standard housings. Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 44, Penna.

Circle No. **35** *on Reply Card*



Self-Cooling Motors Approved For Explosion-Proof Service

. . . or where dampness, dust, and corrosive fumes prevail. The Type SS, totally-enclosed motor needs no exterior fan or heat-dissipating fins. Approval for explosion-proof service has been made by Underwriters' Laboratories, Inc. A slinger protects the output shaft bearing against the entrance of dirt or water. An Underwriters' approved drain plug permits release of water from the interior with no loss of explosion-proof characteristics. Motors are available immediately in range from 1/3 to 2

Send for descriptive bulletin CT-102

EXCEL-SO

CALIBRATING TANKS

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TERMINALS
PIPE LINES
TANK TRUCKS
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PUBLIC SEALERS

We have built hundreds of these provers in all capacities from 50 gallons to 50 barrels. . . . This experience enables us to deliver a REAL PRECISION INSTRUMENT that is Guaranteed. Building, calibrating and guaranteeing a calibrating tank is specialized, painstaking work and is definitely "out" of the price-per-pound category. These tanks are designed to conform to the A.P.I. tentative code #1101, but may be furnished with such modifications as you, the customer, may require.

WARNER LEWIS COMPANY

BOX 3096 • TULSA, OKLAHOMA

(*To obtain more data on advertised products see page* 128)

FOR DEPENDABLE PERFORMANCE

Specify WOLVERINE QUALITY-CONTROLLED CONDENSER TUBES

● Wolverine condenser tube is manufactured in standard diameters, wall thicknesses and lengths—and in a number of alloys. It is packaged carefully to give utmost protection during shipment and storage and for your convenience in handling at time of use—

PLAIN TUBE

In sizes from ⅛″ to 2″ O.D.

Wall thicknesses from .042″ to .180″.

Lengths up to 50 ft.

Alloys: copper, cupro-nickel, aluminum, brass, red brass, 70-30 brass, Muntz metal.

Tempers: All condenser tubing furnished in accordance with ASTM B-111 Specification or similar specifications.

FINNED TUBE

WOLVERINE TRUFIN*
—THE INTEGRAL FINNED TUBE

Furnished with plain ends to permit best assembly.

In nominal sizes from ⅜″ to ¾″—root diameter.

Wall thicknesses from .032″ to .065″.

Alloys: copper, cupro-nickel, red brass, admiralty, aluminum, aluminum-brass, SAE 1010 steel, and stainless steel.

End treatments: *plain ends*, stripped, full-finned, or variations of these end treatments.

WOLVERINE TUBE DIVISION
of Calumet & Hecla, Inc.
Manufacturers of tubing exclusively
1425 Central Ave. • Detroit 9, Michigan

*REG. U.S. PAT. OFF.

Wolverine Trufin and the Wolverine Spun End Process available in Canada thru the Unifin Tube Co., London, Ontario

PLANTS IN DETROIT, MICHIGAN AND DECATUR, ALABAMA
Sales Offices in Principal Cities

Export Department, 13 E. 40th St., New York 16, N. Y.

hp., also fan-cooled to 75 hp., and will later be produced in higher ratings. U. S. Electrical Motors, Inc., Box 2058, Terminal Annex, Los Angeles 54, Calif.

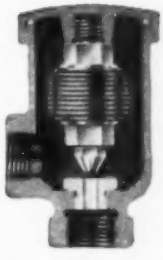
Circle No. **36** *on Reply Card*

New Automatic Pipet Dispenses Controlled Volumes Accurately

. . . at predetermined time intervals. The Maisch Automatic Pipetting System consists of a motorized stainless steel metering pump, an automatic recycling timer, and a pipet control unit. It responds instantly to split-second control of any precision timing switch having adjustable *on* and *off* cycle controls. As soon as the desired volume of liquid is dispensed, flow is recirculated back to the pump intake, maintaining an average accuracy of 0.5 to 1% for the volume being dispensed. The pump maintains a continuously uniform and non-pulsating flow. Pump heads are available in output capacities from 0 to 150 ml./sec. The amount of fluid dispensed during each time cycle is determined by the speed and capacity of the pump selected, the operating head pressure and the time interval to which the pipet control is set. Thus, a pump dispensing at 20 ml./sec. under any given head pressure will deliver 100 ml. when the timer is set for 5 sec. Motorized transmission units are available with fixed speeds for output capacities from 11 to 150 ml./sec.; also with governor-controlled variable speed universal motors for adjustable output capacities from 3.4 to 30 ml./sec., and variable speed transmissions for adjustable capacities from 0 to 150 ml./sec. Units are designed for continuous operation under full load with 110/115 v., 60 cycle AC power. Central Scientific Co. 1700 Irving Park Rd., Chicago 13, Ill.

Circle No. **37** *on Reply Card*

Thermostatic Bellows Steam Trap Is Made in Small Size



. . . for individual drainage of small pieces of equipment. It is recommended for such applications as tracer lines in refineries and chemical plants, and also for automatic air vent for mechanical traps, receivers, etc. The body is a bronze casting, the cap a brass forging, and the gasket is copper-covered asbestos. Bellows is constructed of phosphor bronze, hydraulically formed, and attached to end plates of new design, ample hexagon end fittings permit the use of an open-end wrench to tighten the bellows into the trap cover without straining the bellows element. Bellows is charged with distilled water and internal pressure parallels that on the outside and prevents collapse. Valve and seat are made of hardened stainless steel, accurately ground. Traps operate on a few degrees temperature drop of condensate (according to pressure) and with a very slight back-up of condensate. They are made in sizes ¼, ⅜, ½, and ¾ in., in angle type for pressure from vacuum to 200 psi. W. H. Nicholson & Co., 12 Oregon St., Wilkes-Barre, Penna.

Circle No. **38** *on Reply Card*

Trade Literature

Pump with No Moving Parts

. . . is a displacement type operating on compressed air. Four-page folder, Ejectopump, includes dimensions, capacities, and air consumption of various models. Ferro Corp. Supplies Div., 4150 East 56th St., Cleveland 5, Ohio.

Circle No. **39** *on Reply Card*

Measurement by Radioactivity

. . . of such variable as liquid level and interface liquid level, surface films, specific gravity, unit wt. per unit area, gas or liquid composition. Basis is a density gage cell in which radioactive energy is converted directly to electrical energy. Described in Bulletin 104, *Ohmart Density Gauges, a Null System of Measurement*. The Ohmart Corp., 2347 Ferguson Rd., Cincinnati 38, Ohio.

Circle No. **40** *on Reply Card*

New Gas Analysis Reagents

. . . in four types for unsaturated hydrocarbons; a) for total olefins, ethene, propene, butent, and pentenes, b) for selective absorption of isobutene, c) for propene, butenes, and pentenes, and d) for acetylene and higher in the acetylene series: and another for carbon dioxide, or hydrogen sulfide, sulfur oxides, and other acidic gases. Bulletin No. 327. Burrell Corp., 2223 Fifth Ave., Pittsburgh 19, Penna.

Circle No. **41** *on Reply Card*

The Importance of Emptiness

. . . is the subject of a 12-page booklet, *Vacuum—the Magic Hat of Industry*, written in non-technical language about the uses of vacuum and methods of producing it. Ingersoll-Rand Co., 11 Broadway, New York 4, N. Y.

Circle No. **42** *on Reply Card*

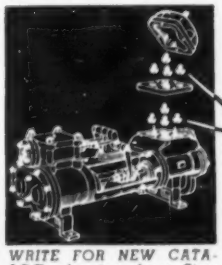
Electrostat Precipitator Rapper

. . . for continuously cleaning electrodes in Cottrell Units, using an intensity-controlled, magnetic impulse

BETTER PUMP PERFORMANCE MEANS *Less Maintenance*

SIMS PUMP

Sims Pump Valves are guaranteed to give you better pump performance. And that means time, money and tempers saved.



1. Discs rotate for minimum wear while cushioned by liquid top and bottom. 2. Inclined ribbed seat and cushioned stem head combine to give smoother, faster valve action and take up shock.

WRITE FOR NEW CATALOG showing how Sims Valves fit your pump for better performance.

VALVE CO., INC.

145 HUDSON ST., NEW YORK 13, N. Y. • M & M BLDG., HOUSTON, TEXAS

(To obtain more data on advertised products see page 128)

rapping system based on electric pulse techniques developed for radar. Bulletin MI explains the operation with circuit diagrams and illustrations of major components. Research Corp., Bound Brook, N. J.

Circle No. **43** *on Reply Card*

Southwest Research Institute

. . . and its activities are described in its 5th Annual Report, 5 *Years & The Future;* including projects in industrial waste disposal, gum formation problems in natural gasoline plant absorber oil, fuels, lubricants, and engine research, etc. Southwest Research Institute, 8500 Culebra Rd., San Antonio, Texas.

Circle No. **44** *on Reply Card*

Petroleum Processing Index

. . . for the year 1952. It includes subject and author indexes for all feature articles and regular departments for the 12 issues of this magazine published during the past year. Platt's Petroleum Publications, 1213 West Third St., Cleveland 13, Ohio.

Circle No. **45** *on Reply Card*

Aliphatic Nitrogen Compounds

. . . specifications, physical properties, shipping data, and constant boiling mixtures on a family of 35 compounds available in commercial quantities. Included is a bibliography of important references in chemical literature to these amines and nitriles, as well as a list of 18 amines available in research quantities, and an entire section on specification test methods. Bulletin F-4770, *Aliphatic Nitrogen Compounds,* Carbide and Carbon Chemicals Co., 30 East 42nd St., New York 17, N. Y.

Circle No. **46** *on Reply Card*

Transmission Systems

. . . pneumatic, magnetic, electric, electronic, and electronic follower; for rate of flow, differential pressure, liquid level, viscosity, specific gravity. Design features, operating information, performance characteristics. Catalog T-50. Fisher & Porter Co., Hatboro, Penna.

Circle No. **47** *on Reply Card*

Electronic Level Control

. . . for liquids, granular, and bulky solids; is not affected by conductivity, insulating value, viscosity, temperature, pressure, corrosive properties, or density; has a sensitivity of 1/16-in. Data on two models, their accessories, installation, etc. in Bulletin F-101, *Tektor Level Control,* Fielden Instrument Div. Robertshaw-Fulton Controls Co., 2920 North 4th St., Philadelphia 33, Penna.

Circle No. **48** *on Reply Card*

Synthetic Organic Chemicals

. . . including alcohols, glycols, triols, acetals, plasticizers, esters, ketones, ethers and oxides, glycol-ethers, acids, chlorine compounds, nitrogen compounds, aryl compounds, aldehydes, anhydrides, metallic salts, and "Ucon" fluids and lubricants. 20 pages of physical properties, 1953 edition. Carbide and Carbon Chemicals Co., 30 East 42nd St., New York 17, N. Y.

Circle No. **49** *on Reply Card*

Electric Transmitter

. . . for temperature recorder and controller, with low signal voltage output—0 to 0.5 volts, 60 cycle, A.C. —from a resistance thermometer primary element, and adjustable ranges, —100 to 600° F or —50 to 325° C. Bulletin A-706, *Swartwout Autronic Temperature Transmitters.* The Swartwout Co., 18511 Euclid Ave., Cleveland 12, Ohio.

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. . . of carbon, stainless, and alloy steels. Bulletin 103-Z gives selection data, types and sizes, workability, properties, etc. Globe Steel Tubes Co., Milwaukee 46, Wisc.

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Mass Spectrometer Booklet

. . . covering Consolidated's Model 21-103A; its uses, how it works, method of analysis, performance characteristics, work capacity, personnel requirements, accessories, specifications. Bulletin CEC-1800B. Consolidated Engrg. Corp., 300 North Sierra Madre Villa, Pasadena 15, Calif.

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Electronic Analog Computer

. . . theory, method of setting up problems, and three typical examples; covered in Computer Corp. of America's new catalog on IDA (Integro-Differential Analyzer). Also described is new Model NLU-2 Function Simulator which permits addition of backlash, dead-zone, and limit stops to IDA or any other analog computer. Burlingame Associates, 103 Lafayette St., New York 13, N. Y.

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Information on Stearates

. . . their uses, properties, industries in which they are applied, government specifications, analytical tests, etc. Bulletin 53-1, Witco Chemical Co., 295 Madison Ave., New York 17, N. Y.

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General Pump Catalog

. . . covering wide range of types: standard centrifugals, portables, self-primers, high pressure, verticals, split-case; rotaries, vertical piston pumps, horizontal triplex, etc. *Industrial Catalog* No. I-52. The Deming Co., Salem, Ohio.

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Polyethylene Glycols

. . . "family" book, on the "Carbowax" line; uses physical properties in tables and charts, shipping and storage data, specifications, test methods. Bulletin F-4772. Carbide and Carbon Chemicals Co., 30 East 42nd St., New York 17, N. Y.

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Temperature Measurement

Temperature Recorders, Bulletin 447; 20 pages of description and construction data to aid in the selection and use of temperature measuring instruments; thermal systems are charted, and complete descriptions are provided for rectangular and circular case instruments, temperature bulbs, charts and accessories. The Foxboro Co., Foxboro, Mass.

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Bin Level Control

Dust Bin Level Control, Engineering Data Sheet 823-12; description of a control system which indicates and records temperature as a means for maintaining the level of dust in a collection bin. The Foxboro Co., Foxboro, Mass.

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ADDITIVES, for light oils, Santolene C: Information; Monsanto Chemical Co. See adv't p. 19.

ADDITIVES, petroleum sulfonates: Informative booklet; L. Sonneborn Sons, Inc. See adv't p. 138.

ALLOYS, Sheet and Plate: Information; Haynes Stellite Co. See adv't p. 22.

ANNUNCIATOR SYSTEM, complete, standardized: Catalog 100 on New Panalarm "50"; Panalarm Products, Inc. See adv't p. 18.

BUTYLENE: Booklet S-5 on yield prediction; Filtrol Corp. See adv't p. 48.

CALIBRATING TANKS: Bulletin CT-102; Warner Lewis Co. See adv't p. 139.

CATALYTIC CRACKING UNITS: Information on engineering service; Refinery Engineering Co. See adv't p. 13.

CATALYTIC REFORMING: Information on new "Catforming" process; The Atlantic Refining Co. See adv't pps. 24, 25.

CATALYST SUPPORTS, porous refractory type: Samples and information; Norton Co. See adv't p. 9.

CHARTS, recording: Catalog; Technical Charts Inc. See adv't p. 99.

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CHEMICALS, aromatics: Information; Hooker Electrochemical Co. See adv't p. 37.

COOLING TOWER FAN: Bulletin 1501; Hartzell Propeller Fan Co. See adv't p. 2.

DRUM CLEANING: Booklet F7629; Oakite Products, Inc. See adv't p. 102.

FITTINGS, weld: "Up-to-the-minute facts"; Taylor Forge & Pipe Works. See adv't p. 1.

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HEAT EXCHANGER TUBES, brass and alloys: Case histories; The American Brass Co. See adv't p. 4.

HEAT EXCHANGERS, brazed aluminum: Answers to tricky heat transfer problems; The Trane Co. See adv't p. 49.

HEAT EXCHANGERS, shell and tube: Bulletin HE-6; Henry Vogt Machine Co. See adv't p. 111.

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INSTRUMENTATION, centralized control by graphic panel: Composite catalog No. 5000 on complete line; Minneapolis-Honeywell Regulator Co. See adv't pps. 16, 17.

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MIST AND SOLIDS ELIMINATORS: Bulletins on purifiers; The V. D. Anderson Co. See adv't p. 47.

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VALVES, for pumps: New catalog; Sims Pump Valve Co., Inc. See adv't p. 141.

VALVES, refinery, corrosion-resistant: Bulletin V-217; Rockwell Mfg. Co. See adv't pps. 30, 31.

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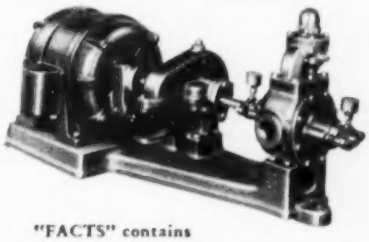

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EDITORIALS

Overhauling of Mines Bureau Liquid Fuels Program Needed

ONE project of the outgoing Administration in Washington which should come under the scrutiny of the new Congress is the work of the Bureau of Mines in the petroleum field. The Bureau's synthetic liquid fuels experimental program has already cost the taxpayers $87,600,000 since 1944, including the 1950 appropriation extending the work until April, 1953. It is a question if the practical means for producing liquid fuels in volume, from either oil shale or coal, are further advanced than they would have been had the experimental work been left to the oil companies.

As authorized by Congress April 5, 1944, the Mines Bureau has built a demonstration plant in Colorado to extract and refine oil from shale, and one in Missouri to hydrogenate coal. Also, as authorized, it has prepared engineering estimates of the cost of commercial-scale plants in both fields. The results to date from this part of the program have been about as predicted when the measure was introduced into Congress—a meager amount of demonstration and laboratory data which has been the basis of estimates for commercial plants. The validity of these estimates has been questioned both within the oil companies and in other scientific quarters. Misleading data has been issued by the Bureau both on the need for a commercial synthetic liquid fuel industry in this country, and on the importance of its work in paving the way for a commercial industry.

Some phases of the Bureau's work have been of value. Its studies of the nature and extent of the oil shale beds in the Rockies have supplied basic information needed if and when the time comes to build plants to make liquid products from shale. It has also developed new, improved methods for mining the shale, work which is outside the natural province of the oil companies. It has also done some basic work with coals essential in the possible future commercial manufacture of liquids by hydrogenation or Fischer-Tropsch synthesis.

Insofar as the Bureau's studies have extended into the processing operations for either shale or coal, it is doubtful if further work will prove any more valuable than the studies to date. Processing techniques change rapidly and will continue to do so, and the oil companies will keep ahead of the Bureau in this work since it is close to their operations in processing petroleum and gas. Review and revision of the synthetic liquid fuel program by Congress should limit the Bureau to basic studies which the oil companies are not in a position to carry on. With the present investment in physical facilities, this can be done at far less cost than the synthetic liquid fuel program has incurred so far.

There is also another phase of the Bureau's activities which should come under the scrutiny of the new Congress. This is the work of the long established Petroleum and Natural Gas Branch, which became a stepchild of the outgoing Administration, with its vision of paternalism to a full-scale synthetic liquid fuel industry. The entire appropriation from the Bureau's regular funds for this work in the fiscal year 1949 was $606,000. Among several activities, this covered the cost of operating the Petroleum Experiment Station at Bartlesville, Okla.

In addition to other work at the Bartlesville station, two important studies are now being carried on which could be made of considerable immediate value to the refiners and to consumers of petroleum products. In one project, financed in part by the API, intensive study is being made in isolating and analyzing the many sulfur compounds occurring in petroleum. This work is fundamental to the development by refiners of improved methods for processing the increasing volume of high sulfur crude being produced. The second study at Bartlesville, to the cost of which the Western Petroleum Refiners Assn. is contributing, has to do with the basic improvement of diesel fuels as regards stability and other properties. Important work in oil and natural gas production has long been carried on at Bartlesville, as at other field stations of the Mines Bureau. Revision of the program of the Bureau under the new Administration at Washington should include providing more financial support to the activities of the established Petroleum and Natural Gas Branch.

Overhauling the work in the petroleum and gas field, of the Mines Bureau, can greatly increase the value of this agency to the oil companies, and at considerable saving of taxpayers' money. —V.B.G.

Correcting the Human Variable

IN THE past few years great progress has been made in improving the analytical test methods the petroleum industry uses for product control purposes, from the point of view of accuracy and reproducibility. Successful testing must still depend to a large degree however, on the carefulness and training of the operator in the laboratory. The Natural Gasoline Assn. of America has recognized the difficulties in commercial transactions that arise through the variations in test results in different laboratories or on tests by different operators in the same laboratory. It organized a training school for natural gasoline analytical chemists at the University of Oklahoma.

Opened in October, the school is a series of short courses of three weeks' duration with but 10 students per course period. The students are partly trained operators from natural gasoline plants and other laboratories. They are instructed in the finer points of analysis with standard equipment, particularly on the elimination of costly human errors.

This work looking toward standardizing analytical techniques on an industry-wide basis offers many benefits. Inter-company transactions will be simplified through reducing the variation in test results on products sold. Individual companies will be saved from overshooting on product quality because of improper test techniques. Higher goals of accuracy for individual laboratories will result from the training their men receive in the training course. The NGAA has taken a progressive step in establishing its permanent training school for natural gasoline plant analysts. —V.B.G.

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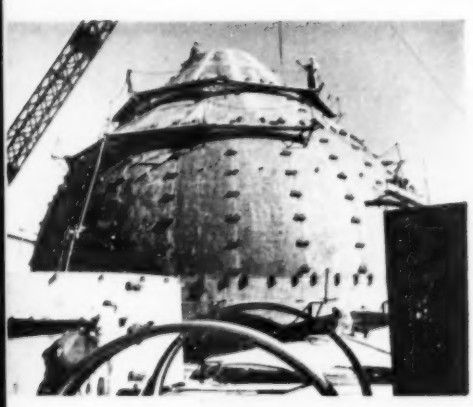

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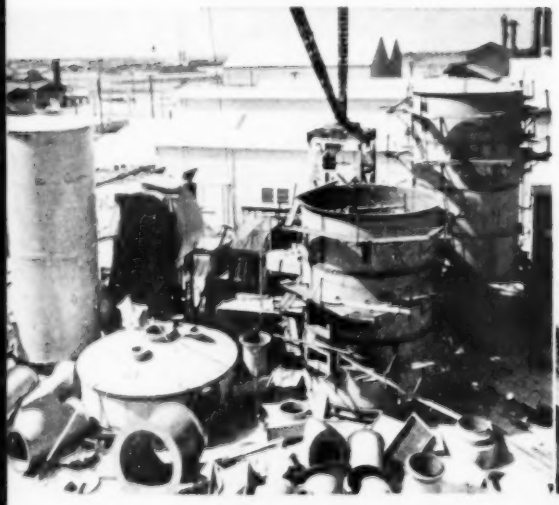

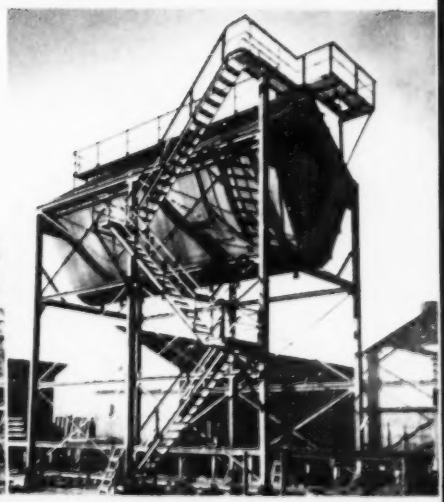

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